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Experimental Hybridization of *Triturus v. viridescens* and *Triturus v. symmetrica*

By James C. Lipsett and Jean Piatt

Introduction

CONTIGUOUS ranges, presence of intergrades in region of overlapping, and general similarity are the usual criteria employed by taxonomists for subspecific allocation. There is one other factor which is coming to be more widely used, however, in drawing a distinction between a species and a subspecies and this whether the intergrades show an intermediate condition in all the parent characteristics or whether certain characters always tend to dominate. In other words a distinction may be drawn between two distinct species which are capable of interbreeding but whose offspring do not show a thorough blending of characters, and two subspecies whose offspring show a complete mixture of the parent strains. It is supposed that true species owe their divergence to single factor allelomorphs and obey the simple law of Mendelian Dominance, while subspecies differences are of a multiple factor nature and consequently show a phenotypic blending.

For a number of years herpetologists have considered the common northern form of *Triturus viridescens* and the striped gulf coastal plains form to be of subspecific rank. This subspecific allocation for the two forms is based upon the fact that they obey Jordan's Law and that intergrades have been reported from North Carolina, the region where the ranges of the two overlap. To the best of our knowledge the exact nature of these intergrades have not been studied with the end in view to ascertain if they were true subspecific crosses or merely the result of distinct species fertile inter se. With this in mind we have undertaken the hybridization of *Triturus viridescens viridescens* and *Triturus viridescens symmetrica* under controlled conditions in the laboratory to determine if possible the systematic status of the two forms. It was thought that if the F_1 generation showed a true intermediate condition they should be considered subspecies; if the color pattern of one form dominated greatly that of the other they might be looked upon as distinct species. Inter fertility per se has long since ceased to be a reliable criterion for species delineation.

Experimental

Hybridization of the two subspecies was begun in February when the gonads are normally inactive. Gonad stimulation was obtained by implantation of female frog (*Rana pipiens*) hypophyses, two per day for three days, after the early method of Rugh. Ovulation occurred usually on the fourth day; the males attempted amplexus as early as the first day.

As a precaution against residual sperm from spring fecundations all the females received slight cloacal traumatization and boric acid douches several days prior to operation.

The matings were arranged in four series, two homospecific crosses and

two heterospecific crosses. In series 1 *viridescens* females were mated with *viridescens* males; in series 2 *viridescens* females with *symmetrica* males; in series 3 *symmetrica* females with *viridescens* males; and in series 4 *symmetrica* with *symmetrica*.

Amplexus in the homospecific series was normally vigorous; but in the heterospecific series was always desultory and soon abandoned. Spermatophores were deposited without the protracted *liebesspiel*. Rejection of the females in this type of mating has been ascribed to chemical differences in the products of the hedonic glands. Since females were never observed to pick up spermatophores, fecundation of the heterospecific series was accomplished by injecting sperm clusters into the cloaca with a pipette. This was repeated several times although the conspicuous white balls of sperm were nearly always retained.

Eggs and Early Embryonic Stages

The eggs of the two subspecies differ considerably in pigmentation: the *viridescens* egg is light brown at the animal pole and yellow below, while the *symmetrica* egg is greenish yellow above, becoming pale yellowish white below. The hybrid eggs were purely maternal in pigmentation, as is to be expected.

No detailed study was made of cleavage, but the pattern and rate were similar in all cases.

The pigmentation noted in the eggs persisted in the embryos until after the tail-bud stage when conspicuous differences in the arrangement of chromatophores developed. The *viridescens* embryos showed diffuse distribution of the chromatophores over a brownish yellow background; in the *symmetrica* embryos the chromatophores were massed along the lateral line to form a distinct black stripe over a pale yellow ground color. The hybrids, series 2 and 3, differed only slightly from the *viridescens* type, series 3 (*symmetrica* mother) having chromatophores more localized in the lateral line region but in no way approaching the sharp definition of the *symmetrica* type. There was no difference noted in gill structure, limbs, etc. that could be analyzed.

A month after hatching the *symmetrica* larvae had lost their black stripes. Remaining were large black spots scattered over the lateral and dorsal surfaces of the head and body. The *viridescens* larvae maintained their diffuse distribution of chromatophores. The hybrids were so indistinguishable from each other and from the *viridescens* larvae that great caution had to be exercised to avoid mixing them during examination. All series had acquired a brown ground color above and white on the ventral surface.

Nearly three months after hatching, as metamorphosis approached, the *viridescens* larvae developed a rusty brown ground color. Distinct white spots appeared along the lateral line, the forerunners of the definitive red spots of the adult. The *symmetrica* larvae and the hybrids did not acquire the rusty tinge but exhibited the lateral white areas with certain notable differences: in *symmetrica* they were white stripes broken at intervals to form long bars. The majority of the hybrid larvae had the small circumscribed spots of the *viridescens* type; a few in both series, however, showed

spots which tended to coalesce and form short bars. This coalescence was especially extraordinary since it *never* occurred in the *viridescens* larvae. It was evident that these forms manifested a slight degree of intergradation between *viridescens* and *symmetrica*.

Description at Metamorphosis

On May 1, 1935, all of the series, both controls and hybrids, were killed (with the exception of two individuals from the 3 series) and preserved. Three of the series, 2, 3, and 4, were at this date three months old, the 1 series was four and one-half months old. This discrepancy in age does not, however, invalidate the 1 series as controls. All four series were in a very late metamorphic stage and although the 1 series was slightly larger in bodily proportions the color pattern was in no more advanced condition than the others. Previous examination of individuals from the two parent stocks has revealed the fact that there are no morphological characters of sufficient significance or constancy to merit description; the only character by which *viridescens* differs from *symmetrica* is in that of pigmentation.

The preserved material shows that series 2 and 3 approach the *viridescens* type of pigmentation to a much greater extent than to that of *symmetrica*. There is no noticeable difference between the 2 and 3 series themselves. Although individuals from both hybrid series show indications of a slight barring, the spotted condition of *viridescens* is distinctly more prevalent. The 4 series show the more or less typical striping effect and differ also both from the hybrids and normal *viridescens* in that they possess a distinct clumping of the chromatophores, whereas the normal *viridescens* and the two hybrid series do not show this character to any marked degree. The very early differentiation found between the 2 and 3 series has completely disappeared. This would seem to indicate that this early difference was due solely to the influence of the maternal cytoplasm.

Conclusions

Inheritance in Amphibia is known to be complicated by the frequent involvement of multiple factors. If the characters, spot and stripe, were simple unit allelomorphs we should expect all the F_1 hybrids to resemble one or the other parent exclusively in this respect. The presence of a few hybrids of both crosses exhibiting slight but definite blending or intergradation suggests the participation of multiple factors; a heterozygous constitution in one or both of the stocks; or a combination of these two. We do not possess locality records for our *symmetrica* and therefore cannot discuss the possibility of genetic contamination. We can only conclude that hybridization produces a *viridescens* type with a few cases of imperfect dominance. If the percentage of blending is a valid distinction between species and subspecies as mentioned above, *viridescens* and *symmetrica* may be distinct species, fertile inter se.

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Casual Notes on the Poikilothermous Vertebrates of the Umzumbe Valley, Natal, South Africa

By Raymond B. Cowles

THE following observations were made while the writer was primarily engaged in a study of the local avifauna and even while the notes were being collected it was realized that the list of cold-blooded forms would in all probability be incomplete. Publication of the notes in this form was not at first contemplated but it is now thought that enough material of interest is represented in them to justify their use. This is especially true since the crowding together on the native locations of the Zulus is having some very obvious effects on animal habitats.

Symptoms of the coming changes were altogether too evident even while these notes were being recorded, and the signs were not confined to the one area alone but were to be found in most native locations. The natives are being crowded together on the steeply sloping hillsides where white men find it impossible to cultivate the soil. This is forcing the natives to remove the protective natural vegetation of grass, shrubs, trees and bush and to cultivate steeply sloping lands that are frequently subjected to torrential rains.

Changes are taking place in all the habitats and ecological niches of the varied fauna of these areas, and in many cases drastic changes have taken place or are taking place now, so that it seems advisable to place on record in a permanent form all available data.

Although several species of fish were present in the river and its tributary streams no attempt was made to collect either notes or specimens. Apparently two species of eels are present, one being known as *umBogwane*, the other as *iBalane* by the Zulus. The eels attain an enormous size for fresh water species, some reaching a length of several feet with correspondingly large girth, and specimens from other rivers than the Umzumbe have been reported with weights exceeding sixty pounds.

A number of other smaller species of fish are present, some in considerable numbers, and for many of them the Zulus have regular names. Among the most interesting is the *isiKwali, Tilapia natalensis*.[1] This species attains an estimated weight of about half a pound, although from observations at Umzumbe it is thought that such individuals are rather rare. The adults find their way from the larger reaches and pools of the river to small reed grown shallows along the margins into which they must work their way with some difficulty since in some places the pools are surrounded with fringes of thickly growing reeds. In these smaller pools, the female may be seen superintending her brood of numerous young. The adult at such times usually remains motionless, fanning gently to maintain position and the swarm of young move about in a rather compact group to a distance of several feet from the parent. If the adult sees danger approaching or is otherwise alarmed, it may move forward a few inches, but with no other per-

[1] Identification by Dr. J. T. Nichols.

ceptible signal or sound it can warn the young that it is time to seek shelter. The entire compact group darts toward the parent and pours into its opened mouth until the last individual has disappeared, and is safely sheltered. The adult then swims off to deeper water or other shelter.

AMPHIBIA[2]

Xenopus laevis (Daudin): native name, *isiNana.*—Note also the native name for *Breviceps.* This is the most truly aquatic salientian of the region and is also one of the most abundant. Individuals have been caught on a fish-hook baited with worms or fish, but although they will take bait that is lying on the bottom of the stream, it is not as common a trait as might be wished and only a few can be so captured. In order to realize their abundance it is necessary to trap for them, either with or without bait. It was found that the most successful trap was made in the form of a wire netting basket about 10″ x 2′ x 3′, with openings at each end. These open ends were so arranged as to lead either fish or frogs into the basket, then more or less hamper their escape. It was seldom that a single, over-night, set would yield less than two or three of the strange creatures, and as many as fifteen or more often crowded into the trap at one time.

Bufo regularis Reuss: native name, *iSelesele.*—This is the most common toad of the region, and is present at all times of the year although not in great numbers. Usually a few are to be found either in the neighborhood of houses, where they seem to find conditions to their liking, or elsewhere where satisfactory shelter is often afforded by man's changes in the natural environment. Like the common toads of North America, it is not found in an aquatic habitat except during the breeding season, so that for most of the year it may be looked for in almost any type of moderately dry environment where at the same time there is sufficient humidity to prevent desiccation during the daytime. Such places are usually found in the vicinity of water-tanks, under culverts or in drains, or under houses, in holes in the ground or crevices under rocks. At night when the relative humidity is ordinarily much higher than in the daytime, the toad wanders about in the open not far from its retreat, picking up such food as is on the move.

The toads become particularly noticeable when certain nocturnal species of termites are in their nuptial flight, and they are then to be seen out in the open, excitedly picking up the fluttering insects and feeding voraciously. Later on in the evening they have sometimes been seen sitting in one place as though stupefied, almost unable to hop, and loath to move, stuffed to repletion and only active in the movement of their forelimbs which are lifted from time to time to brush at an adhering wing.

Hyperolius undulatus (Boulenger), *H. concolor* (Hallowell), *H. marmoratus* Rapp and *H. horstockii* (Schlegel).—These species were found associated and apparently in equal numbers. They are responsible for most of the noise produced in the swamps and along the streams during the nights of the rainy season. Within a few yards of a favorable location the din is at times almost deafening and it is often necessary to shout in order to

[2] The writer is indebted to Dr. G. K. Noble for the determination or verification of nomenclature of several of the following species of amphibia.

make one's self heard at a distance of only a few feet. *Hyperolius ocellatus* Günther was also collected.

Phrynobatrachus natalensis Boulenger.—Uncommon; only two collected.

Rana oxyrhynchus Smith: native name, *umJamu.*—This frog is quite similar to the common American frog, *Rana pipiens,* in its habits, but it was never abundant and even in the most favored locations not more than five or six would be seen in the course of a morning walk.

Breviceps mossambicus Peters: native name, *isiNana.*—This is the species to which the above native name is most properly applied. Its use in conjunction with *Xenopus* is probably due to the common confusion of native names.

The natives are familiar with this peculiar little creature and during the plowing season, September and October, frequently turn them out of the soil where they are brooding their eggs at a depth of about four inches.

Individuals with their eggs, and specimens containing eggs that were apparently about to be laid, were brought in during the last five days of September, and even as late as October 20.

The parent digs into the ground, and at a depth of three to four or five inches enlarges the tunnel to a space with ample room for itself and the cluster of eggs.

The eggs have the appearance of partially cooked tapioca, and remain attached to each other by their gelatinous capsules.

Several attempts to discover the life history were made from time to time, but the specimens kept under artificial conditions failed to develop, and those that were kept under what was hoped were natural conditions, were invariably destroyed by hordes of small red ants. In one case, even the parent was killed and partially skeletonized by these ants.

Breviceps parvus Hewitt:[3] native name, *isiNana.*—This species appeared to be quite rare, for only two specimens were collected and no observations on habits were made.

Reptilia

Pelomedusa galeata (Schoepff): native name, *isiFudu.*—These little terrapins are abundant in some of the smaller streams flowing between steep banks of mud or clay. They occur in the larger rivers and streams as well, but in this vicinity seem to be present in greatest numbers in the slower, muddier tributaries.

Lygodactylus capensis Smith: native name, *isiBankwa.*—These common little lizards are particularly numerous about human habitations where they may be watched in their pursuit of prey and in their various interesting antics during courtship. One finds their eggs in various protected crannies, between flakes of bark, under stones and logs, and, in fact, in almost any warm, well protected spot. The eggs are frequently yoked together in pairs, although the majority seem to be laid separately, or at any rate, do not adhere to each other.

Agama atrata Daudin.—Presence noted; one specimen collected. Not common here.

[3] Synonymized with *B. pentheri pentheri* Werner by Parker in A Monograph of the Frogs of the Family Microhylidae, 1934.—Ed.

Varanus exanthematicus albigularis (Daudin): native name, *umBulu.*—Only two individuals of this species were collected and only two more were seen. At first glance, or when seen escaping through the underbrush or into a tree, they resemble the next species so closely that identification is made exceedingly difficult. It seems probable that they are far more common than the records of their occurrence indicate.

The Nile monitor, *Varanus niloticus,* is almost amphibian in its habits during the warmer months and even during the winter is seldom found very far from water, whereas *Varanus e. albigularis* is seldom seen near streams and the individuals that were observed were all found in dense cover fairly high up on a hillside, and either perched on a ledge or some other vantage point. This difference in distribution is by no means diagnostic, however, for although the range of *V. e. albigularis* is apparently limited to a particular habitat, *V. niloticus* invades it in all particulars, even to the arboreal habit.

Varanus niloticus (Linnaeus): native name, *uXamu* or *uQamu.*—Either native name seems to be correct. These large lizards are fairly common although they appear to be less numerous than previously. If true, the condition can be readily understood from a study of their life history.[4] Their eggs are laid in the termitaria of one of the most common species in the district, but one which is subject to various destructive elements due to the existence of man in their vicinity. The *Varanus* eggs require approximately nine months in which to develop and during this period are entirely dependent on the very specialized environment for their incubation. It is probable that the ant-bear, *Orycteropus afer,* now extinct in the valley, did far less damage to *Varanus* eggs than do the native bulls and the native children.

Chameleon sp.—Only one chameleon was collected, and this was an immature individual. The chameleons are doubtless far more common than the occurrence of only one individual in a collection would indicate; the natives' familiarity with them is further evidence that they are common. Eggs were found in the ground, at a depth of about three inches, and although they hatched, the individuals were too young at that stage to be identified. The eggs were plowed up November 2, and hatched January 30.

The chameleons are detested by the Zulus and are killed whenever caught. The favorite method is to insert a pinch of snuff in the victim's mouth, an act which results in fairly immediate death and appears to be rather humane in comparison with methods in vogue with some reptile collectors.

The native aversion to the species is due to a legend in which the lizard, *isiBankwa,* was given the message of death and the chameleon the message of life. The chameleon loitered on the road to earth and spent its time catching flies, the lizard darted along in sudden spurts and reached the earth first, thus bringing death into the world. The native reaction to this legend is curiously illustrative of their sense of justice. Resentment is not wasted on the messenger that was ordered to bring death, and carried out its tragic errand, but on the laggard that did not follow orders.

[4] Cowles, R. B. Journal of Entomology and Zoology, 22 (1); 1930.

Python sebae (Gmelin): native name, *Idhla 'mbila* (Hyrax eater) and *uMonya*.—No pythons were observed by the writer, and only one track was seen. The track which was seen could hardly have been that of any other snake owing to its great size.

One python was collected in a clump of weeds near the river about 1916 by Frederick Cowles and contained a full grown duiker, probably *Cephalophus grimmi*, and another was taken June 2, 1926. The latter contained eggs which were reported about ready for laying. The two specimens measured 16 feet and 14 feet respectively.

Among the other harmless snakes collected were *Simocephalus capensis* Smith, and *Psammophis brevirostris* Peters (*imFulwa*).

Poisonous snakes were equally rare with the exception of *Dendraspis angusticeps* Smith, the very dangerous *iMamba*. (None of the green color phase was observed.) This species was fairly abundant and although many were encountered in the bush, some at close range, all of them fled, even one exceedingly large specimen which was first observed at a distance of about five feet. An attempt was made to collect this specimen since it was obviously larger than one that measured ten feet in length and had been killed several years previously, but during the interval of changing from large to small shot, it became alarmed and fled.

Within twenty yards of the place where the large individual was seen, a native girl collecting firewood was threatened by an exceedingly large *iMamba* and ran for her life, refusing to go back and bring in the wood, even after a lapse of several days. The bush in which these observations were made was greatly feared by the natives for miles around and very few were willing to hunt, cut wood, or even walk through it. The writer must have spent an aggregate of two or three months at least in tramping back and forth and collecting birds in this particular locality, and probably not over ten snakes of any kind were seen during that period, in spite of the fact that he had heard the native reports concerning that part of cover and had been warned and was therefore particularly alert in watching for danger.

Most of the snakes reputed to lurk in that bush seemed to appear sooner or later in a saddle house built at its edge, led there no doubt by the presence of swarms of rats which had been attracted by abundant food. In this location the *iMambas* lived up to their reputation for viciousness, but when seen they were invariably inside the house and therefore cornered, a situation likely to result in arousing the ire and fear of any spirited animal.

Poisonous snakes other than the *iMamba* were very rare. One puff-adder, *Bitis arietans* (Merrem), *iBululu*, and one opisthoglyph snake, *Dispholidus typus* Smith, were seen or collected, making a rather unimposing list. The particular section in which most of the collecting was carried on had been noted for its snakes not many years previously, but the situation appears to be changing rapidly and it is possible that in a few years one may collect a year at a stretch and see only a few of the small harmless reptiles.

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A New *Anolis* from Mexico

By Hobart Smith

IN 1933,[1] I referred a specimen of *Anolis* from the high mountains of Guerrero between Rincón and Cajones to the species *gadovii*. Since then I have had the opportunity of examining a specimen of *gadovii*, and it is now obvious that the differences pointed out originally (*op. cit.*) define another species, which may be called

Anolis ***dunni***, new species

Holotype.—Taylor and Smith Collection No. 1506, collected July 1, 1932, on a boulder in the high mountains, within the evergreen zone, between Rincón and Cajones, Guerrero.

Diagnosis.—Resembling *Anolis gadovii* Boulenger, in most characters, differing in possessing widely separated, narrow and ill-defined frontal ridges; nares vertically compressed; supraorbital semicircles broadly in contact, separated from the supraoculars by a single series of scales; a large, single series of scales between the occipital plate and the supraorbital semicircles; dewlap reddish.

Further details, with a complete description, are given in the original paper mentioned above. It may be pointed out that the ecological niche occupied by *gadovii* (coastal plain) is quite different from that occupied by *dunni*.

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Two New Reptilian Records from Jost van Dyke, B. V. I., with Notes on Distribution and Squamation

By Chapman Grant

THE Island of Jost van Dyke lies northwest of the small group of the British Virgin Islands, east of our Virgin Islands, which in turn are east of Puerto Rico.

The island appears small, steep, dry, brush-covered, practically uncultivated and almost uninhabited, but interesting. It is the most abrupt of any of the surrounding islands. How little is known of it scientifically may be inferred from the fact that in his *Second List of Antillean Reptiles and Amphibians* (1), which is the starting point for all study of Antillean herpetological distribution, Dr. Barbour mentions only one species of frog and four of lizards as the entire known herpetological population.

It was therefore with great pleasure that I received a collection of one *Dromicus exiguus* and twelve *Alsophis antillensis*, collected on this island, from Dr. Stuart Danforth, the noted ornithologist of Puerto Rico. In working up this small collection, which was later presented to the Museum of Zoology, University of Michigan, some facts were revealed which may be of interest.

[1] Smith, Hobart M. Notes on some Mexican lizards of the genus *Anolis*, with the description of a new species, *A. megapholidotus*. Trans. Kans. Acad. Sci., 36, 1933: 315–320.

Dromicus exiguus Cope

Barbour gives the range of *D. exiguus* thus "St. Thomas, St. John and Culebra. Extinct on St. Thomas, it is probably not uncommon on the other islands."

To this range the islands of Tortola (2) and Hassel [1] have been added by the present writer, who failed to find a specimen on St. John (3) on a five-day collecting trip which added 10 species to the 5 previously recorded. Culebra (4) failed to produce a single specimen, although careful collecting added 3 species, one new, to the 9 previously known. The mongoose is blamed with the destruction of this snake, but the mongoose abounds on Puerto Rico and St. John, and not on Culebra.

It was not a lack of knowledge of the habits of the genus which failed to produce specimens of *exiguus* from Culebra or St. John. *Dromicus stahli* was scarce in collections from Puerto Rico, but 100 specimens were collected by the writer after learning the peculiarities of the snake. It usually inhabits thick, matted grass and can best be found by following a plow when a field, long fallow, is being turned. Collecting behind a plow might bring this genus to light on most of the islands of the Puerto Rico area east of Puerto Rico proper.

Dr. Stejneger states that "The probability is that it will also be found on Vieques" (6: 699). The present writer made a collecting trip to Vieques in 1931 (5), adding 4 species to the then known list. He talked with some natives who had killed snakes within a few years. These may have been either *Dromicus* or *Alsophis*, or both.

The present specimen from Jost van Dyke merits description as it has variations which a series may later show to be of specific value:

No. 246A Grant collection; locality Jost van Dyke, B.V.I.; collector, Danforth, August 20, 1932; snout to vent 25.5 cm., tail broken at 6.5 cm.; no pores on body scales; gastrosteges 139, followed by an "abnormal" half gastrostege; preanal divided; tail broken at 40th pair of urosteges; scale rows 19–17; supralabials 8–8; 3, 4 and 5 enter orbit; infralabials (abnormally) 9–9; loreal on left side (abnormally) fused with the prefrontal, very small on right side; temporals 1 + 2; preoculars 1–1; postoculars 2–2.

Colors: in general—a gray backed snake with flesh colored sides; dark line along center of sides; belly light. Specifically—stippled with tiny brown specks throughout, fainter on belly, which is cream colored; edges of scales heavily stippled along sides; upper half of 3rd and lower half of 4th form a dark line which is more distinct posteriorly; upper half of 4th, all of 5th and 6th flesh colored but with less stippling than 1 and 2; dorsal rows gray.

Alsophis antillensis (Schlegel)

Barbour (1) gives the following range for *A. antillensis*: "St. Thomas, Salt Island, Peter Island, St. John, Tortola, Virgin Gorda and Puerto Rico, also Culebra, Pinero and Dog Island. Extinct on St. Thomas, rare on Puerto Rico, elsewhere abundant." Stejneger lists 5 and the writer took 35 on Culebra (7), and 2 on Water Island of St. Thomas (3). The species is scarce on

[1] Specimens in collections of Museum of Zoology, University of Michigan, and Museum of Comparative Zoology, Harvard University.

St. John; 2 specimens were taken on Dog Island midway between St. Thomas and St. John (3) and 7 on Pinero, an islet very close to Puerto Rico (7). Barbour apparently overlooked 3 specimens listed by Stejneger (6) from Vieques.

Schmidt (8) lists the species from Puerto Rico on the evidence of two specimens, one having 19 scale rows and both having the *antillensis* pattern. Stejneger (6) describes a Culebra specimen of *antillensis* with 17 rows (U. S. N. M. 25556), which is typical of *A. portoricensis*, and my collection of 8 *portoricensis* from Puerto Rico and 4 from Caja de Muertos has several with *antillensis* pattern. It would therefore appear that the presence of *antillensis* on Puerto Rico should await further evidence. By the same token, Schmidt's lumping of Barbour's *A. anegadae* with *A. antillensis* had better await additional evidence of the presence of *antillensis* on Puerto Rico.

SQUAMATION.—All 12 specimens have the body scale formula 19–17–15 and tail 8–6–4–2. Upper labials uniformly 8–8 and lower labials 10–10 except No. 253 which has 9 on right side. All have 1 preocular and 2 postoculars. Labials 3, 4 and 5 uniformly enter orbit. Preanal divided. Two specimens, Nos. 249, female, and 251, male, have a half gastrostege extending from one side to midline, immediately anterior to preanal.

It might be said that the temporals are "normally abnormal." The normal temporals comprise, first, one scale surrounded on 3 sides by the lower postocular, the labials and the parietal; posteriorly by two scales, the upper bordering the parietal and the lower the labials; these followed by three large scales abreast, the upper bordering the parietal, the lower the labials and the center between these two; following these three large scales the small nuchal scales begin. This "normal" temporal formation occurs on both sides of 5 specimens and on one side of 4 specimens. The commonest variation is of a fourth large scale following the upper of the last tier of temporals (6: Fig. 171). This occurs on both sides, as shown by Stejneger, in one specimen only, No. 253, and on one side of 6 specimens. The next most common and more prominent variation is for the 2nd and 3rd large scales bordering the parietal to be fused into one. This occurs on both sides of 2 specimens and on one side of 3 specimens. In one specimen on one side the first temporal is fused with the following upper scale. In one specimen on one side, the second and third scales bordering the parietal and the one below the third are fused into one large plate. In another, on one side the three scales bordering the parietal are fused into one long temporal. In another, the anterior point of the left temporal is clearly cut off into a separate scute.

The diamond-shaped scale fitting into the niche between the ends of the parietals is subject to considerable variation in size and as a consequence, the ends of the parietals may be bordered by 3, 4 or 5 scales, three predominating. In one case, the three scales are not only fused together, but are also fused with the large scale following the third upper temporal, making a single scale 5 scales wide and the depth of only one.

SCALE ROW REDUCTION.—Ruthven and Blanchard describe the method of dropping scale rows as exemplified in a number of genera of snakes. These writers found that approximately the center scale row on each side is the

first to disappear. Following posteriorly the next rows lost are alternately either immediately above or below the first row dropped.

In *Alsophis antillensis* a characteristic color pattern occurs on rows 5 and 6. It might be expected, therefore, that these rows would not be lost because it is unlikely that a longitudinal pattern should move from row to row. In the present species, the 4th row is dropped first; then instead of a contiguous row disappearing, there is an upward skipping of four rows and the pair of rows bordering the central or dorsal row is dropped.

In the genera studied by Ruthven and Blanchard, the row to be dropped usually decreases in size; frequently reappears for a short distance and sometimes abuts against a large scale. In the present species, the rows end only by abutting against a large scale which frequently bears three pores instead of the usual two. Rows 4 and 5, and 8 and 9 diminish equally in size as they approach the large terminal scale. It may be therefore obscure which is the terminating row, but the "axiom" which is pointed out in another article [2] for *Natrix* seems to hold for this species. Namely: "The scale *nearest* the terminating scale is the last of the row which drops out."

The diminution of scale rows on the tail again is radically different from *Natrix*, in which the following reduction takes place: the center row drops out anterior to the vent; the rows bordering the center row (the highest) and numbers one (the lowest) *continue* to the tip; a row about half way between the first and the center row extends nearly to the tip. In *Alsophis*, the center row drops out opposite the vent; the first extends to the tail tip and a row on each side about half way between the first and the center row extend nearly to the tip as in *Natrix*, but instead of the rows bordering the center row continuing to the tip, they are the *first* to drop out; then the next center pair and then the next, so we have the six central rows dropping out early together with the second and third.

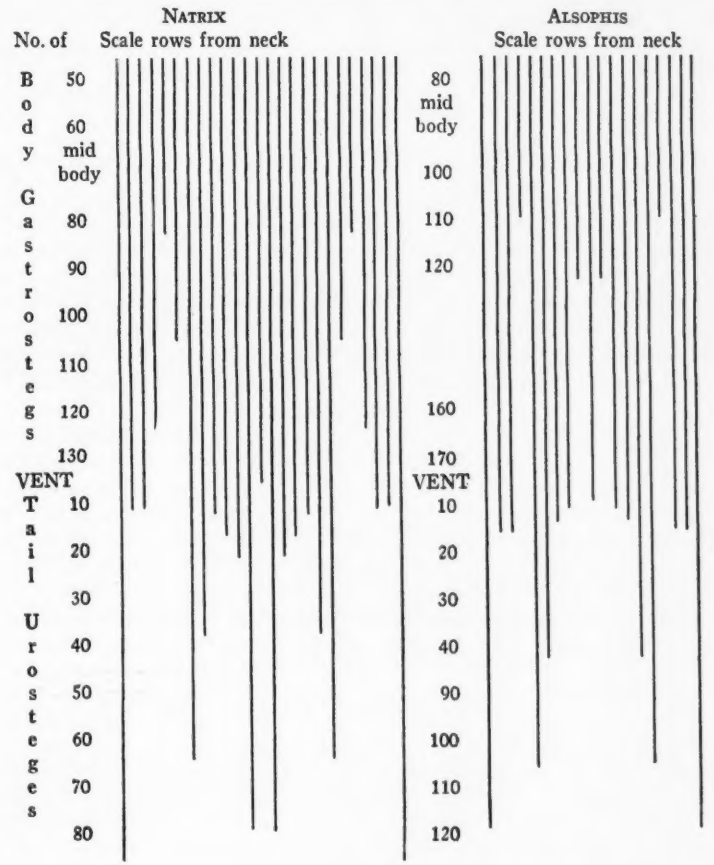
The manner of termination on the tail is different from that on the body. The fifteen body rows continue to the vent where they abruptly reduce to eight rows of large scales, some without pores. Further reductions occur when two rows *undiminished* in size abut almost simultaneously against a very large scale with three, four or five pores. This large scale is followed by several other large scales of multiple pores before diminution in size occurs.

Sexual Variation.—Sexual variations are fairly constant and although the series is not large enough to speak with finality, the following appear to be sexual differences. The males are more prone to be reticulated and have more dark edging to gastro- and urosteges than the females. The body scale rows seem to end similarly, but on the tail, which is longer in the male, the reductions are more distal. The average expressed in the number of the urosteges is:

Number of rows	from 8 to 6 at	6 to 4 at	4 to 2 at	2 to end at
Males reduce	15	45	115	140
Females reduce	10	40	100	125

[2] *Natrix sipedon sipedon* in central Indiana, its individual and sexual variation. Amer. Mid. Nat., 16 (6), 1935: 921–931.

CONDENSED DIAGRAM OF TERMINATION OF SCALE ROWS IN:



Condensed diagrams of row reduction in *Natrix* and *Alsophis* showing that in both genera No. 1, or the lowest row is the strongest; that the central or spinal row stops at the region of the vent; that a row about half way between No. 1 and the spinal row is very strong. The contrasts are: the body rows in *Natrix* reduce in a group, alternating above and below the first row lost. Thus, 5–6–4. In *Alsophis* there is not alternation, but a wide skipping. Thus, 4–9. In *Natrix* the rows bordering the spinal are next strongest after No. 1. In *Alsophis*, nearly the weakest.

Note that the strong rows in *Alsophis*, 5 and 6, are the rows which bear the particolored pattern.

The diagram of *Natrix* is ideal, as there is great variation and irregularity among individuals as well as bilateral asymmetry, but the diagram well illustrates the general rule. *Alsophis* has but little variation and is almost bilaterally symmetrical.

I believe that the fewer the rows and the swifter the snake, the more important bilateral symmetry becomes.

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Notes on the Breeding Habits, Eggs, and Embryos of *Bufo cognatus* with a Description of the Tadpole[1]

By ARTHUR N. BRAGG

DESPITE the fact that the Great Plains toad, *Bufo cognatus,* is common in many places within its range, apparently its eggs and tadpoles have never been described. Wright and Wright (1933) in a description of this toad say, "Little is known about the eggs and tadpoles." Similarly, Smith (1934) indicates, "Larvae unknown; eggs unknown."

Recently an exceptional opportunity presented itself for the study of the tadpole of this species, the results of which are embodied in this report. Incidental observations upon the breeding adults, the eggs, and the growth of the larvae are also included. A more detailed description of the eggs is planned for some time in the future.

On the evening of April 18, 1935, the first heavy rain for several weeks fell at Norman, Oklahoma. The next evening *Bufo cognatus* males were calling from shallow temporary pools. By 9 P.M. many pairs were clasping and could be easily picked up without disturbing the reactions of the clasping males: six pairs were collected and placed, still clasping, into a large tank

[1] Contributions of the Zoological Laboratory of the University of Oklahoma, No. 144.

of water in the laboratory. At 10:45 A.M. the next day one female was laying eggs, some of which were collected and reared to tadpoles. Subsequently, other eggs from the same pools were collected and cultured. Larvae from both sources were reared in flat glass dishes set in direct sunlight. The water was changed frequently at first, but after the animals had become free from the jelly envelopes, it was changed only when it appeared to be becoming turbid. Algae from nearby ponds were used as food.

As is well known, the call of the anuran male during the breeding season attracts the female. In several cases in my observations females were seen to move toward singing males but no reaction on the part of the males could be observed till the females were nearly or quite in contact with them. Amplexation is pectoral in *B. cognatus*, as surmised by Smith (1934), and is not essentially different from that of other large bufonids such as *B. americanus*. Clasping is continued for several hours before eggs are laid. On my original visit to the breeding pools there must have been at least a hundred pairs in evidence although they were not counted. At 9 A.M. the following day there were no eggs in the pools. Twenty-four hours later several clutches were found with embryos in the blastula stage.

The eggs are laid in strings in the manner typical of bufos as the female crawls about more or less on the bottom. Usually a single row of eggs is produced but occasionally a string will be double (Figs. 1 and 2), and the same female may exhibit both habits of egg laying in a single clutch of eggs. Egg counts were not made but there must have been several thousands of eggs in the single clutch laid in the laboratory.

The embryos become externally ciliated by the time that the neural tube closes and may rotate in the jelly. The ciliary beat is strong and is directed backward. Under the cultural conditions employed in my work, the embryos hatched in approximately fifty-three hours and immediately began a slow locomotion while lying on their lateral surfaces, a movement largely accomplished by ciliary action.

Active muscular movements are evident before the embryos leave the jelly but the young tadpoles do not swim much till about ten hours after hatching. When about thirty hours old, all of the tadpoles swim in a spiral path, the majority of them rotating to the left although some were seen to turn to the right. That the direction of spiralling is not due to a reaction to light or to temperature is indicated by the fact that two larvae from the same clutch of eggs and in the same container may differ in this respect. When about seventy hours of age, the larvae begin to lose the tendency to spiral and then swing widely from side to side with only an occasional turning over. About ninety hours after hatching, all spiralling ceases.

In my tadpoles there was a great variation in total length, between individuals of the same age. Adolph (1931), working with *Rana*, found that size variation resulted from overcrowding and that the effect was caused by the tadpoles failing to eat. Rugh (1934) showed that space, apart from other factors, produced the same effect.

My tadpoles were overcrowded, especially in the early stages, but size differences began to appear before the development of the mouth. Therefore, the observed size differences could not have been caused by differential rates

of ingestion alone. The space factor may have been operative and, if so, is interesting, since Rugh worked upon larvae of a considerable older stage of development. No attempt was made to control the various ecological factors in my cultures but, since the size variations occurred within the confines of single dishes, all of the animals within any given culture were subjected to very nearly the same environment. This type of control seems to me adequate and it is the method used by Rugh (1934). While at all ages size variations were observed, measurements were made only upon young tadpoles. Table 1 gives the individual lengths of two sets of larvae of two different ages. It should be noted that the younger larvae show a greater variation in length than the older ones.

TABLE 1

Comparison of Lengths of Individual Tadpoles of *B. cognatus* of Two Ages (Measured in mm. from Bouin Fixed Material in 70% Alcohol)

53 hours after fertilization		117 hours, 45 min. after fertilization	
3.20	2.32	4.50	5.80
0.95	1.90	4.75	5.75
1.26	2.68	4.00	5.10
2.90	3.20	5.10	4.50
3.40	1.98	5.10	5.30
2.00	2.92	5.00	5.00
2.00	2.66	4.80	5.50
2.58	1.82	5.00	5.50
3.20	2.20	5.10	4.80
3.68	1.84	5.00	5.00
2.62	2.00	4.75	4.75
2.20	2.14	5.60	5.00
2.56	2.60	5.50	5.30
2.20	2.40	5.50	5.00
2.20	2.78	5.10	5.00
2.20	1.60	4.00	5.20
1.40	2.60	5.00	4.50
Average 2.45—		5.03—	
Range 0.95—3.68		4.00—5.80	

The early tadpole (at about 5 mm.) is almost black, a condition common in *Bufo*, with a ventral coloration lighter than the dorsal. A fairly sharp line passes along the lateral surface dividing the dorsal, pigmented area from the lighter ventral region. This line passes posteriorly from the head region just dorsal to the external gills and then curves ventrad to the vent (Fig. 6).

By the time that the tadpole has reached the length of 8 mm. the color pattern has become more definite. A low-power binocular reveals a gray background not visible macroscopically. On the dorsal and lateral surfaces this background is largely obscured by close-set black areas of pigment, each oval in outline (Fig. 1). Between the tip of the snout and the nares there is a fan-shaped darker area which narrows posteriorly toward the eyes and passes between these as a dark line along the middorsal line of the back.

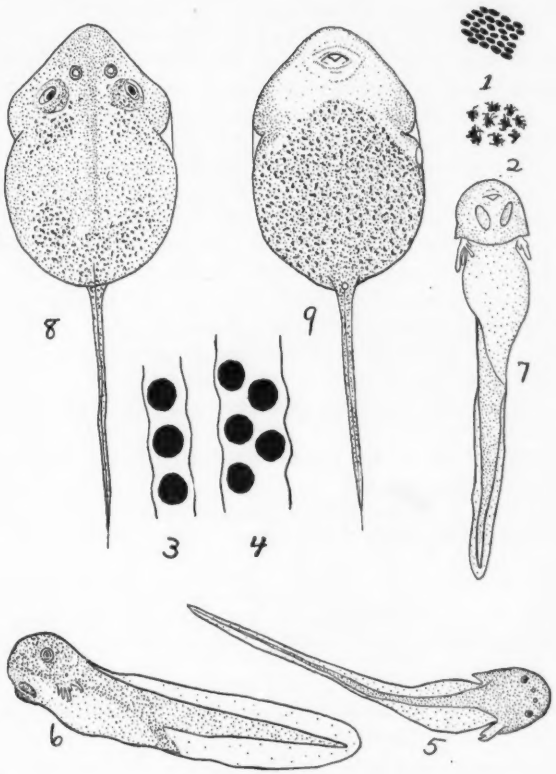

PLATE 1

Fig. 1. Small black areas (malanophores?) from the skin of an 8 mm. tadpole.
Fig. 2. Chromatophores from the dorsal surface of an 8 mm. tadpole.
Fig. 3. Portion of an egg string.
Fig. 4. Portion of a double egg string.
Fig. 5. Dorsal view of a 5.2 mm. tadpole; age, 107 hours after fertilization (X 11).
Fig. 6. Lateral view of tadpole shown in Fig. 5.
Fig. 7. Ventral view of a 5.5 mm. tadpole; age 107 hours after fertilization (X 10.25).
Fig. 8. Dorsal view of an 8 mm. tadpole (X 10).
Fig. 9. Ventral view of an 8 mm. tadpole (X 10).

This gradually fades out posteriorly. Scattered chromatophores, silvery in appearance and irregular in outline, occur on most of the dorsal surface posterior to the eyes. In five areas these chromatophores tend to be more or less aggregated. There are two such areas, one on each side, posterior to the eyes; a second pair occurs caudad to these in the posterior region; the fifth area is to be found just anterior to the tail in a median position (Fig. 8). In some individuals this median area tends to merge with the posterio-lateral pairs in such manner that there appears to be but one roughly crescent-shaped area in the posterior region. In older larvae all of these areas tend to unite as the pigmentation develops. Ventrally, the color pattern is equally definite (Fig. 9). The ventral surface of the head is mostly unpigmented and, therefore, of a nearly uniform gray although bordered laterally by black spots descending from the sides. At the anterior border of the abdomen the gray area extends obliquely caudo-laterad, reaching to the spiracle on the left and to a corresponding position on the right. Chromatophores tend to invade these oblique gray areas (usually there is more invasion on the right than on the left). The remainder of the abdomen is covered by golden chromatophores fairly evenly distributed over its surface.

The eyes are large and black. The nostrils are two light-colored circular openings without lids of any kind. The spiracle is a circular opening on the left side. The tail fin is fairly highly arched dorsally and contains scattered black dendritic pigment spots. Ventrally, the tail fin is clear at this stage. The mouth parts are fairly well developed but are better seen in older larvae.

Measurements of a single 8 mm. tadpole were as follows:

Total length	8.00 mm.	Snout to post. edge nares	0.20 mm.
Body length	6.40 mm.	Snout to spiracle	0.50 mm.
Tail length	1.60 mm.	Interorbital distance	0.40 mm.
Greatest width	0.82 mm.	Internasal distance	0.20 mm.

When the tadpole reaches a total length of 20–25 mm., the hind legs begin to appear. At this time the color pattern is well developed and the mouth parts are fully formed.

Macroscopically, the dorsal surface appears mottled with brown and gray and, although still quite dark, presents a distinctly lighter appearance than earlier. The microscope reveals various types of chromatophores, silvery areas being conspicuously interwoven with black ones. The ventral surface is now markedly lighter than the dorsal. On the throat, there is a greenish-yellow iridescence which extends caudad along the sides of the abdominal surface, gradually shading into grayish-green. The central portion of the abdomen shows a reddish iridescence which is marked with very fine black and golden spots.

The viscera, earlier seen with ease through the body wall, are now only slightly or not at all visible although the beating of the heart can readily be seen.

The tail fin is highly arched (Fig. 10). The pigmentation is still principally on the dorsum although a few dendritic markings may occur on the ventrum, posteriorly. All of the dendritic markings of the tail fin are made up of grouped chromatophores.

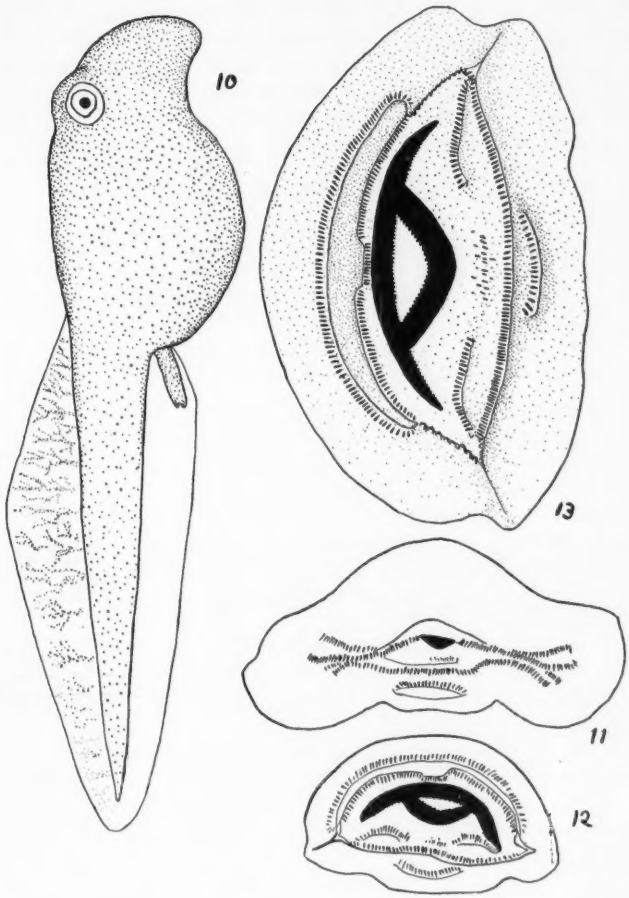

PLATE 2

Fig. 10. Lateral view of a 25 mm. tadpole (X 5).
Fig. 11. Mouth parts of a 25 mm. tadpole as seen when the mouth is closed. Drawn with a camera lucida.
Fig. 12. Camera lucida sketch of the mouth parts of a 25 mm. tadpole with the mouth open and the labia spread apart.
Fig. 13. Semidiagrammatic presentation of the mouth parts of a 25 mm. tadpole made from the study of a live specimen.

The mouth parts are shown in Figs. 11, 12, and 13. The jaws are horny, black, and serrated. The upper fringe of labial teeth is complete but, in the center of its lower portion, the teeth are set nearer to the jaw for a short distance. The lower fringe is incomplete. Scattered teeth also occur in a median position just ventral to the lower jaw. Outside the lower jaw and ventral to it there is an extra lip-like flap which bears teeth on its dorsal border. Thus, the labial dental formula is $\frac{2}{3}$ as in some other bufonids. Papillae are limited to the labial borders.

The iris of the eye is golden.

Measurements of a single, live individual were as follows:

Total length	24.1 mm.	Interorbital distance	2.0 mm.
Body length	10.5 mm.	Internasal distance	0.8 mm.
Tail length	13.6 mm.	Snout to spiracle	5.2 mm.
Greatest body width	5.3 mm.	Spiracle diameter	0.4 mm.
Greatest body depth	4.6 mm.	Length posterior limb bud	2.2 mm.
Tail depth	4.7 mm.		

Summary

Amplexation in *Bufo cognatus* is pectoral and the clasping instinct is strong. Eggs are laid several hours after clasping occurs as the female moves along the bottom. Egg strings are usually single but sometimes double. Tadpoles may hatch in fifty-three hours. At and before this time, they are externally ciliated and their first locomotion is by cilia. The first muscular swimming results in a spiral movement, the turning usually occurring to the left. All spiralling ceases 143 hours after fertilization. Individual larvae vary in size at the same age, the variation appearing prior to the development of the mouth.

Very young tadpoles are almost black. At 8 mm., they are assuming a color pattern and becoming lighter. When about 25 mm. in length, the body is mottled brown and gray dorsally and has light greenish-yellow and reddish iridescences ventrally.

The tail fin is highly arched and dendritically pigmented dorsally; there is but little pigment ventrally. Mouth parts include (1) serrated jaws, (2) complete dorsal dental fringe, (3) an incomplete ventral dental fringe, and (4) an extra lip-like structure bordered dorsally by teeth. The iris of the eye is golden.

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Pictorial Phylogenies of Deep Sea Isospondyli and Iniomi

By William K. Gregory and G. Miles Conrad

THE Herculean labors of ichthyologists and palaeichthyologists have amassed enormous stores of material for the study of the evolution of fishes; the majority of papers, however, are limited to the description of particular collections and apart from the writers of text-books only a few recent investigators feel free to deal with problems of larger scope. But if ever a subject so diffused is to be worked over in order that more general results may be reached and may be made more widely comprehensible, it must be by the method of sampling and the samples must not exclude the positive data of palaeichthyology. By the continuous and conscientious application of Gill's aphorism, "analysis must precede synthesis," the taxonomists have broken down into much smaller and more natural groups the families and genera recognized by earlier ichthyologists; but now the movement toward synthesis seems timely.

The present paper, which is the first of a new series, has grown out of studies on the phylogeny of fishes begun by one of us in 1903. Our aim is to acquire a general idea of the sequence of body forms in various groups of fishes and to visualize our results, however tentative they may be, in the form of pictorial family trees.

Our method is to start with a small number of simple outlines and try to arrange them in divergent lines from one or several stem forms. During repeated trials and discussions we constantly consult the literature of the subject and check our tentative results against the conclusions of systematists. As our acquaintance with the group progresses we gradually increase the number of forms studied until representatives of the more conspicuously differentiated forms have been considered. Wherever possible we have recourse to the skeletons of representative types and pay special attention to the characters of the teeth, jaws and general skull pattern, etc.; nor do we neglect the records of palaeichthyology insofar as they tend to establish the general sequence of body forms.

The deep sea Isospondyli and Iniomi, as observed by A. S. Woodward and by C. Tate Regan, are the highly specialized relicts of more primitive isospondyls of Cretaceous age.

The Deep Sea Isospondyli

The oldest and most central Isospondyli are the family Leptolepidae, abundant in Jurassic and Cretaceous times and appearing to lead directly to the modern clupeoids. Likewise the deep sea Isospondyli and Iniomi of the present time, however various in body form, all seem to lead back to the clupeoid stock in the broad sense.

In a general way the fishes considered here seem to fall into the following groups:

Clupeoidei (Jordan): Alepocephalidae.
Stomiatoidei (Jordan): Enchodontidae, Gonostomidae, Astronesthidae, Chauliodontidae, Stomiatidae, Malacosteidae, Idiacanthidae, Sternoptychidae.

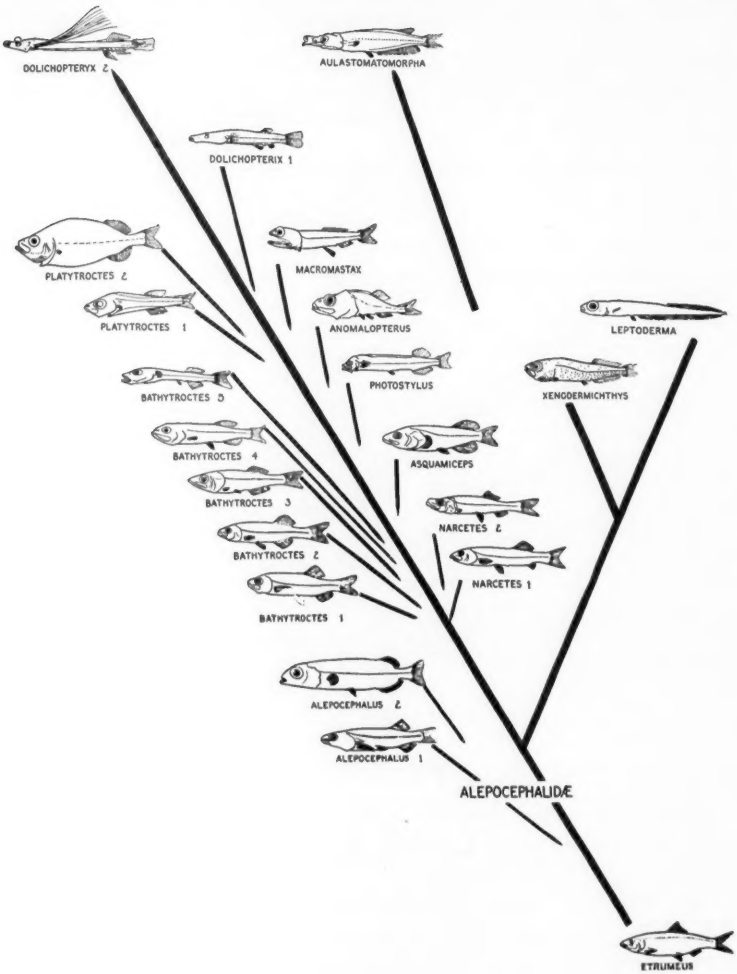

Fig. 1. Pictorial phylogeny of the deep-sea Isospondyli (part I).

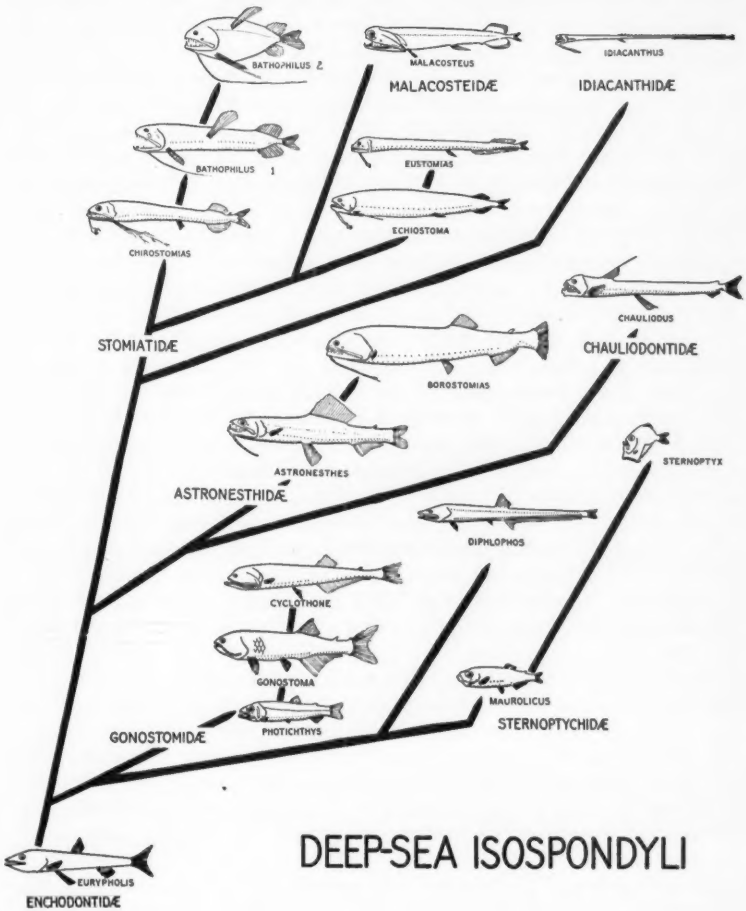

Fig. 2. Pictorial phylogeny of the deep-sea Isospondyli (part II).

CLUPEOIDEI

ALEPOCEPHALIDAE.—Fowler (1934: 245) figured several Alepocephalidae on the same page with *Etrumeus albulina,* a member of the clupeoid group Dussumieriidae (Stolephoridae). The comparison thus implied serves to emphasize the possible derivation of the Alepocephalidae from such a clupeoid as *Etrumeus.*

As the most primitive form of the family Alepocephalidae we have chosen for our chart *Alepocephalus andersoni* (Fig. 1, 1) which retains the general form of the clupeoids as well as the accessory pectoral scale. *Alepocephalus rostratus* (2) differs from *andersoni* chiefly in the smaller size of the pectoral fin and the lack of the accessory scale. The entire genus is characterized by an oblong, compressed body; rather large, thin and cycloid scales; a moderate-sized mouth, with the snout somewhat protruding; no teeth on the maxillaries; and the dorsal fin opposite the anal.

Narcetes is superficially quite similar to *Etrumeus.* The members of the genus present a somewhat elongated body with moderate-sized scales and with the dorsal fin set anteriorly to the anal. The relatively small mouth of *Alepocephalus* is here somewhat wider, and the lack of maxillary teeth in the former is replaced by small, fine teeth in *Narcetes.* Of the two species of *Narcetes* in the chart, *N. garmani* (1) seems to be the least specialized, whereas *N. pappenheimi* (2) with its small pectorals and its upturned snout would appear to be the present end form of the genus.

Of about 19 species of *Bathytroctes* (Beebe, 1933a: 21) we have figured on the chart 5—*B. zugmayeri, hataii, rostratus, welshi* and *drakei*—which show all gradations of superficial similarity with nearby genera. In order of the abundance of individuals *Bathytroctes* ranks first in the Alepocephalidae. *B. zugmayeri* (1) with its clupeoid-like fin form, that is, with the dorsal fin preceeding the anal, has been placed at the base of the genus. In *B. hataii* (2) the dorsal and anal fins oppose each other, while in *B. welshi* (3) the pectoral and pelvic fins are somewhat smaller and the cleft of the mouth is much wider than in either of the preceeding forms. *Bathytroctes rostratus* (4) returns to the dorsal–anal relationship of *zugmayeri,* but is easily distinguishable from the other members of the genus by the character of the first premaxillary tooth, which is enlarged and directed almost straight forward, and by a fleshy supraclavicular process immediately behind the operculum which may or may not be the remnant of the accessory scale of the clupeoid stem. *B. drakei* (5), in body form at least, is the end form of the genus on the chart. The pectoral has developed a pad and the pelvic fins are very small. The body is moderately compressed, elongate and tapers gradually from the shoulders to the base of the caudal.

The genus *Platytroctes* seems to fall on the same side of the line as *Bathytroctes,* for a glance at *P. procerus* (1) shows at once a general similarity in body form between it and *B. drakei.* However, *procerus* has become more specialized in that it has lost its pelvic fins and the humeral arch which terminates in the middle of the chest has developed a long, projecting, acute spine. The two genera agree in having this humeral spine and in having the maxillary, intermaxillary and mandible with a single series of small teeth,

but differ in that the palatine is smooth in *Platytroctes* and toothed in *Bathytroctes*. In *P. apus* (2) the body becomes greatly deepened, but in both species figured the dorsal and anal fins oppose each other.

Off to one side are grouped *Xenodermichthys* and *Leptoderma*. We have little to guide us but Goode and Bean, who do not hesitate to state that these two genera are closely allied to each other and that *Leptoderma* differs from *Xenodermichthys* chiefly in its smaller mouth, great inequality of dorsal and anal fins and the extremely elongate body.

Asquamiceps longmani seems to have arisen from the common alepocephalid stem at about the same level as *Bathytroctes*, from which it differs principally in having a shorter caudal peduncle, a larger head and a rosette-like pectoral fin.

Photostylus and *Anomalopterus*, the next two genera in the ascending line from the clupeoids, differ from all the rest of the Alepocephalidae in having a prominent predorsal adipose fold along the back. *Photostylus* is unique among related genera in having a very small head and a steeply ascending concave snout. The pectorals are well developed and are placed quite high as in *B. drakei* or *Platytroctes procerus*. *Photostylus* and *Anomalopterus* agree in being scaleless and in having teeth on the premaxillary and mandible in some species, as well as on the maxillary and palatine. *Anomalopterus* is, like *Asquamiceps*, an extremely large-headed alepocephalid in which the pectorals and pelvics are rather small and the dorsal fin is set ahead of the anal in the "primitive" manner. The presence of the predorsal adipose fold in these two genera (and in no others of the family) would seem to indicate their close relationship, or at least the convergence of the two.

Macromastax with its naked, delicate skin, very large head and mouth, and its minute pectoral fins, appears to be a step higher in our scheme. With the exception of its lack of a predorsal fin-fold it is fairly similar to *Anomalopterus*.

Aulastomatomorpha has been given a place at the top of the chart in the general area of *Leptoderma* which it resembles, certainly posteriorly to the head. The body is rather elongate as in *Leptoderma* and the fin placements and relative sizes are not widely dissimilar. It is an extreme specialization, however, in having the anterior bones of the skull produced into a long tube terminating in a narrow mouth.

The most bizarre of the Alepocephalidae are found in the genus *Dolichopteryx*. *Dolichopteryx longipes* (1) is almost cylindrical and moderately elongate, has the primitive dorsal–anal relationship and the moderately long pectoral rays arising from well developed pads. The eyes of this form are telescopic and directed straight upward. *D. binocularis* (2) is quite similar to *longipes* except that the dorsal rays of the pectorals in the former have been enormously lengthened.

STOMIATOIDEI

ENCHODONTIDAE.—Tate Regan (1911) concluded that the Cretaceous Enchodontidae, formerly referred to the Iniomi, were in reality Isospondyli and close to the Stomiatidae. They seem, indeed, to make even better struc-

tural ancestors to the related Gonostomidae. They are also related to *Sardinioides,* the stem of the Iniomi, and as already known, the boundary between these "orders" is vague.

GONOSTOMIDAE.—*Photichthys* seems the least advanced of this group, certainly with regard to its dorsal–anal fin relationship and its tooth arrangement. Both jaws in *Photichthys* are armed with a single series of teeth, and those on the maxillary are small and equal in size. In *Gonostoma* the teeth, while still in one series, are all unequal in size (large ones alternating with small). The dorsal and anal fins have their origin opposing each other, but the anal is lengthened posteriorly. It has the body covered with large scales, conspicuous photophores, palatine and pterygoid teeth and well developed pectorals and pelvics. *Cyclothone* seems to represent the end form of this family.

ASTRONESTHIDAE and CHAULIODONTIDAE.—These families are first represented on our chart by *Astronesthes gemmifer,* with its small, close set maxillary teeth directed obliquely backward and a triangle-shaped posttemporal. *Borostomias panamensis* is a slightly more specialized form with few maxillary teeth set well apart and a long, slender posttemporal bone. *Borostomias,* although an end form to its own group, shows a striking approach to the true stomiatids in the general shape of the head and in the presence of a long submental barbel.

In *Chauliodus sloanei* the dorsal fin is set very far forward while the anal remains in the same relative position as in *Astronesthes;* the long barbel is greatly reduced. It also resembles the latter genus in that the maxillary teeth are small, close-set and directed obliquely backward. The skull, too, according to Regan (1929: 31) is of the same general pattern, while the rest of the skeleton is also extremely like that of the Astronesthidae, with the exception of the enormous enlargement of the first vertebra (as long as the next five). This specialization no doubt takes the strain produced when the head is thrown back. On the whole, however, this is a very compact group.

STOMIATIDAE, MALACOSTEIDAE, IDIACANTHIDAE.—*Chirostomias* and *Bathophilus,* as described by Tate Regan, are very much alike except for their dentition and the lateral pelvic fins of the latter. In *Bathophilus* the first premaxillary tooth is of medium length and fixed, the second is long and depressible, while in the lower jaw the first tooth is quite long and fixed with two or three outer fixed teeth behind it and an inner row of depressible teeth, whereas in *Chirostomias* the teeth in the jaws are fixed. *Bathophilus* has lost the parietals which are found in *Chirostomias.* In *Bathophilus brevis* (2) we find an extreme and aberrant specialization marked by a secondary shortening and deepening of the body, by the elongation of the barbel and the extreme lateral position of the pelvic fins which are situated above the lateral line, and by the substitution of a luminous patch on the middle of the side, between the origin of the dorsal and anal fins, for the serial photophores.

Echiostoma barbatum with its typical stomiatid dorsal and anal fin opposition and with its isolated, produced ray in the pectoral fin leads the way to *Eustomias dactylobolus* in which the typical stomiatid dorsal–anal rela-

tionship is upset, the anal fin being produced anteriorly, and the pectorals are entirely absent.

The family Malacosteidae undoubtedly was derived from the common stomiatid stem and reaches its extreme form in *Malacosteus danae* which has the typical fin relationship of the remainder of the group. *Malacosteus danae* differs from the others in this "division" in that the head is vertically movable, the mouth wide, the suspensorium very oblique, the barbel lacking and the serial photophores missing.

Idiacanthus ferox is apparently derivable from the Stomiatidae for with the exception of the anterior elongation of the dorsal fin and the extreme lengthening of the body it is essentially stomiatid in appearance. The extraordinary characters of its larval form, *Stylophthalmus,* and its extreme sexual dimorphism (Beebe, 1934) mark it, however, as a highly aberrant and perhaps early offshoot of the stomiatid stem.

STERNOPTYCHIDAE.—*Maurolicus* has been selected for the chart as the most generalized form of the sternoptychids. *Maurolicus* with oblong body, a slightly prominent lower jaw, a wide, oblique cleft of mouth, a primitive dorsal–anal fin grouping, a rudimentary adipose fin and a naked skin with silvery pigment seems to be near the base of two diverging lines—one toward *Diphlophos* and the other to *Sternoptyx.*

In *Diphlophos* the short rectangular body of *Maurolicus* has been stretched out, with the result that the mouth cleft is only slightly oblique and the anal fin has been greatly lengthened. The rudimentary adipose is entirely absent but the projecting lower jaw is retained.

On the other hand the *Maurolicus*-like form has been greatly deepened dorsoventrally to give rise to *Argyropelecus* and *Sternoptyx.* The body of *Sternoptyx* is extremely deep and compressed and passes abruptly into a short and compressed tail; the angle made by the hind margin of the trunk and the lower edge of the tail is filled by a broad fold of the integument of a peculiar transparent appearance. The body is scaleless and covered with a silver pigment. The pectoral fins are well developed; the pelvics are small; the dorsal–anal relationship is essentially that of *Maurolicus.* The adipose fin is usually absent, as foreshadowed in *Maurolicus.* There seems little doubt as to *Maurolicus,* with its naked and silver pigmented skin, being a forerunner of *Sternoptyx.* Garman (1899: 232) stated in further support of this thesis: "The resemblance between very young *Argyropelecus* and the adult of *Valencienellus* or *Maurolicus* indicates that the ancestral form of the first was approximately the present form of the last."

DISCUSSION AND SUMMARY

The conservatives of the present chart are placed at the bottom, the progressives crowd the middle zones and the freaks are more sparsely distributed in the three upper levels. The alepocephaloid assemblage in general have large heads and very large eyes; the mouth, originally small and never armed with long teeth, becomes very large only in *Macromastax;* this genus suggests *Malacosteus* of the stomiatoids with its terminal eyes and huge jaws, but differs widely in body form, fin placement, etc. The absence in this

family of a normal adipose fin is noteworthy as is also the tendency for the dorsal and anal to be opposed. No true light organs are developed. Among the freaks, *Aulastomatomorpha* may have been derived from relatives of *Leptoderma* by the development of a tube-like mouth and a secondary shortening of the dorsal fin. *Dolichopteryx* may have been derived from a close relative of *Bathytroctes drakei* by the development of "telescopic" eyes.

In wide contrast to the alepocephaloids are the sternoptychoids and the stomiatoids, both possessing elaborate light organs, a small adipose fin and, typically, a large predaceous mouth with teeth extending along the maxillae. The eyes are typically small, rarely large. The body is typically elongate, with the large anal fin not originally paired with the more central dorsal fin. The Sternoptychidae are exceptional in the curious oblique deepening of the body; in the stomiatoids the body is normally very long, but it is secondarily deepened in *Bathophilus brevis*. Barbels appear in the middle and higher levels of the group; the fishes finally attain extremes of voracity in the stomiatoids and *Chauliodus*. In some of these forms the cervical vertebrae become diversely specialized either to permit extreme bending back of the skull, or to brace the occiput against the thrust of the huge jaws.

Viewed as a whole the adaptive radiation of these deep-sea isospondyls, as in other groups, affords numerous examples of two fundamental methods of change in primitive patterns. Secondary polyisomerism is illustrated in the multiplication of the light organs in the sternoptychoids and stomiatoids and of the anal rays in *Diphlophos*, while anisomerism is exemplified at almost every turn in the strange distortions of the head and body, in the extreme lengthening of the barbels, in the over-development of the jaws in *Malacosteus* and in their minute size in *Dolichopteryx*.

The Deep-Sea Iniomi

The order Iniomi, although recognized as such by most ichthyologists, has been shown by Smith Woodward and Regan to have been derived from early Isospondyli. Regan (1911) and Parr (1928, 1929) have made important contributions to knowledge of the interrelationships of this confusing group of mostly very specialized deep-sea forms. For the purposes of the present study we may adopt the following arrangement, in which phylogenetic heritage characters are given higher rank than family habitus differences:

Aulopodoidea	Held together by skull characters.
Aulopodidae	Stem forms.
Synodontidae	"Lizard fishes," pike-like aulopods.
Ateleopodidae	Macrurid-like aulopods with extremely long anal and forewardly placed dorsal, ventrals in advance of pectorals. Skeleton arrested, partly cartilaginous.
Chlorophthalmoidea	Highly diversified derivatives of *Chlorophthalmus*.
Chlorophthalmidae	Very generalized; large eyes, flat foreheads.
Bathypteroidae	Eyes reduced or wanting, tactile fin elements.
Ipnopidae	Blind offshoot from *Bathysauropsis*.
Myctophidae	Extreme development of light organs, usually large eyes.
Sudidae	No light organs; large-eyed super-"pikes." Central forms derived from *Chlorophthalmus*.

Omosudidae .....Enormous jaws and teeth.
Alepisauridae .....Dorsal fin secondarily lengthened.
Scopelarchoidea
Scopelarchidae .....Large-jawed predators with dorsally developed eyes.
Evermannellidae .....Very long teeth with barbs.
Cetomimidae .....Extremely aberrant; enormous heads, paired dorsal and anal.

AULOPODOIDEA

AULOPODIDAE.—Regan (1911: 120) agreed with Woodward (1902: 33) in placing the Upper Cretaceous *Sardinioides* close to *Aulopus,* indeed Regan makes it a member of the Aulopodidae. Smith Woodward (*op. cit.*) figured the skulls of *Aulopus* and *Sardinioides* in both dorsal and lateral views with striking results, for study of the figures reveals a very close resemblance between the fossil and living genera. *Aulopus* differs from *Sardinioides* chiefly in having a greater number of vertebrae and in the elongation of a few of the dorsal fin-rays. *Aulopus,* as the most generalized existing member of the order, is characterized by a moderately elongate, little compressed body; moderate-sized scales; a slightly protractile terminal mouth which is rather wide; the maxillary being dilated posteriorly and bearing two supramaxillaries; small conical teeth which form narrow bands in the jaws and on the palate, the palato-pterygoid bands being connected by that of the vomer. The dorsal fin originates shortly behind the head and is rather elongate; the pelvic fins are inserted below or a little behind the pectorals; and an adipose fin is present.

SYNODONTIDAE.—Regan (1911: 124) and Parr (1929: 8) agree that the Synodontidae are but slightly more specialized than the Aulopodidae. As the most primitive on our chart we have figured S*ynodus indicus* which, according to Regan, agrees with *Aulopus* in having a similar vertebral column and in having the pelvic bones developed in much the same way. It differs from *Aulopus* chiefly in having the maxillary narrow posteriorly, in the lack of a supramaxillary and in having the dorsal and pelvic fins set farther behind the pectorals.

As the "end genus" we have figured *Bathysaurus* because of the greater development of the dorsal and anal fins and the unstable condition of the adipose fin which may be present or absent.

ATELEOPODIDAE.—*Ateleopus* resembles *Aulopus* in the form of its cranium. Regan (1911: 133) states, "*Ateleopus* scarcely differs more from *Aulopus* in fin-structure than *Coilia* does from *Engraulis,* and it is especially noteworthy that the many jointed simple or bifid pelvic rays is exactly similar to the outer pelvic rays of *Aulopus* . . . " He is quite satisfied with its derivation from an *Aulopus*-like ancestor, but because of its specialized appearance we have placed it at the top of our chart.

CHLOROPHTHALMOIDEA

CHLOROPHTHALMIDAE.—This family is represented on our chart by the figure of *Chlorophthalmus agassizii.* This genus appears to lie near to the

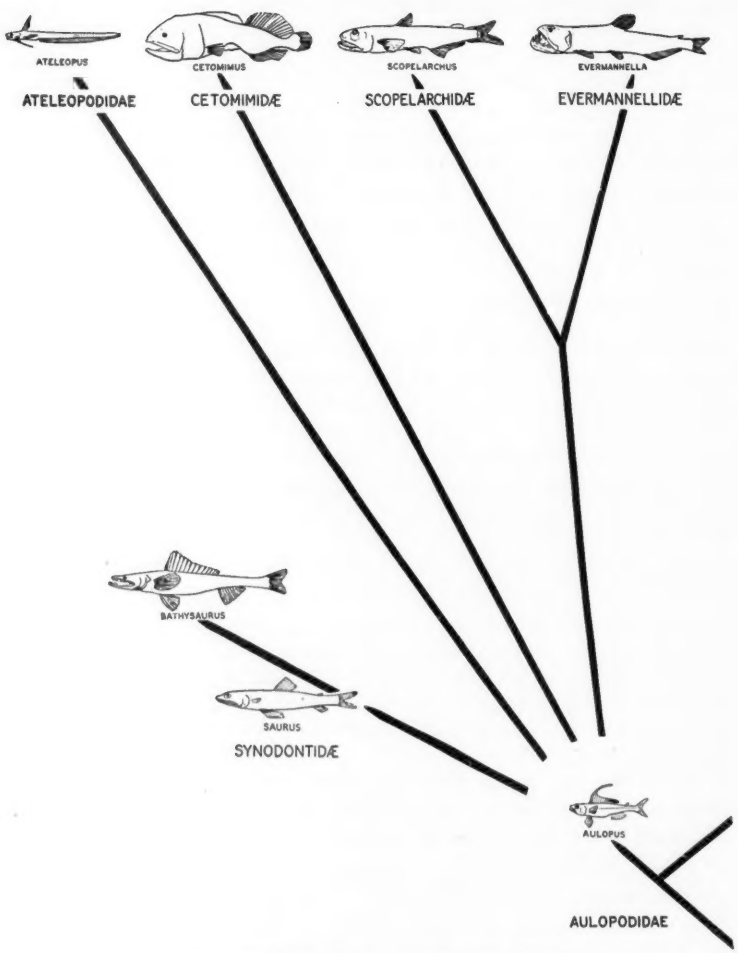

Fig. 3. Pictorial phylogeny of the Iniomi (part I).

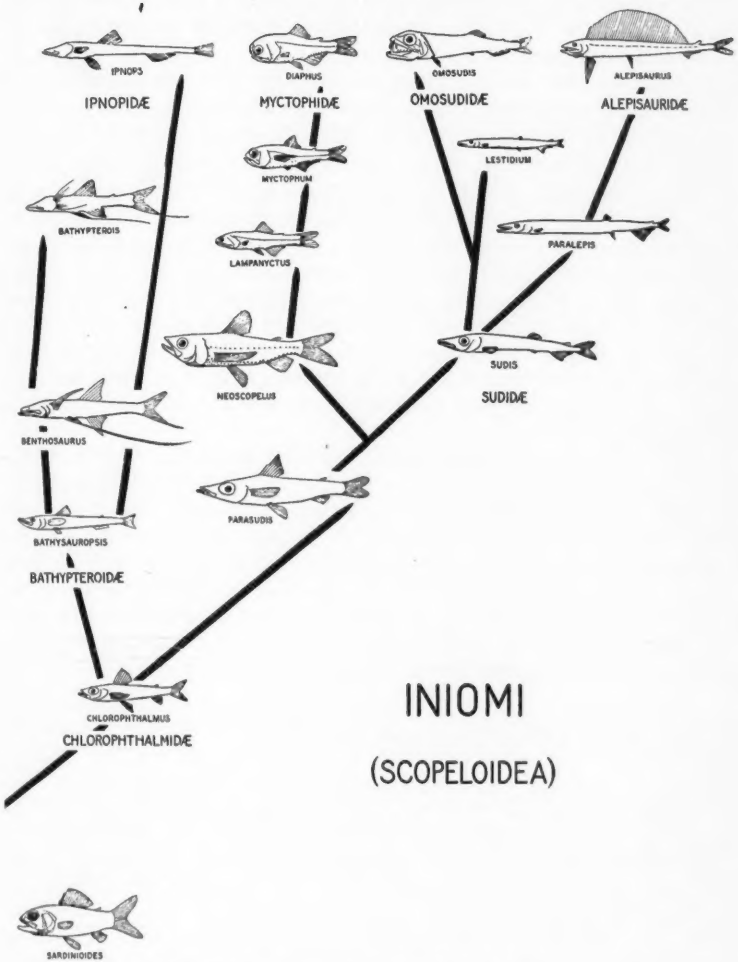

Fig. 4. Pictorial phylogeny of the Iniomi (part II).

Sardinioides–Aulopus line and itself gave rise to two families, the Sudidae and Bathypteroidae. The genus *Chlorophthalmus* is characterized by a rounded body; wide mouth; maxillaries that are long and dilated posteriorly; minute teeth on narrow bands in the jaws, and on the palatines, vomer and tongue. The ventral fins are behind the origin of the dorsal, and the adipose fin is small. It differs from *Aulopus* in that the dorsal fin is short, the maxillary bone bears but one supramaxillary and the vomerine teeth form two separate patches, etc. The coracoids and pectoral radials seem to be intermediate between those of *Aulopus* and of *Bathypterois*. The circumorbital and nasal bones agree with those of *Aulopus*.

BATHYPTEROIDAE and IPNOPIDAE.—Regan (1911: 127) creates a new genus, *Bathysauropsis*, for *Chlorophthalmus gracilis*, which differs from *C. agassizii* in having a more slender body, a depressed head, somewhat smaller eyes, larger mouth, pelvic fins farther forward and pectorals placed higher. It is, according to Regan, intermediate between *Chlorophthalmus* and *Ipnops* on the one hand and *Benthosaurus* on the other. Parr (1929: 4) is in full accord with Regan's disposition of these two families. *Ipnops* is practically identical with *Bathysauropsis* in form, structure, position of fins, etc., but differs greatly in having its eyes completely aborted. The adipose fin is lacking also.

On the other hand, *Benthosaurus* retains the same body form as *Bathysauropsis* with a new arrangement of the fins: the dorsal is barely in advance of the anal, the pectoral is placed high up on the side of the body near the shoulders and the outer ray of the ventrals is produced. *Bathypterois* is but a step farther on from this, for all of the fins maintain their new positions with the rays of the pectoral fin much elongate, some of the upper being separate from the rest and forming a distinct division. The eyes of these last two genera, which are very small, point out the tendency in these families for their eventual absorption as seen in the Ipnopidae.

MYCTOPHIDAE.—Regan (1911) in his paper on the anatomy and classification of the Iniomi points out the close relationship existing between the Myctophidae and the Sudidae. From his account we see that they agree in having the vomerine teeth, when present, in two well separated patches, and differ chiefly in that there is a median keel on the ethmoid and that the parasphenoid extends upward to the frontals between the lateral ethmoids in the Myctophidae. In the very generalized myctophid, *Neoscopelus*, which we have chosen for our chart, the skull is less expanded behind the orbits and has the sphenotic process less prominent than in *Aulopus*, while the jaws, the palatine attachment and the posttemporals are very much as in *Chlorophthalmus*. Parr (1928: 16) points out that *Notosudis* Waite 1916 (not figured) is in many ways intermediate between *Chlorophthalmus* and *Sudis* and that in addition it shows a relationship to *Scopelengys* (not figured) of the Myctophidae. On these facts we feel justified in deriving our *Neoscopelus* from a mid-point between *Parasudis* and *Sudis*.

Lampanyctus is a much more specialized form (Regan, 1911). However, the skull agrees essentially with that of *Neoscopelus*. It has been placed at the foot of the subfamily Myctophinae in our chart for its comparatively

simple arrangement of light organs. The remainder of the subfamily (as well as *Lampanyctus*) is separated on the basis of the placement and number of photophores. We have selected *Diaphus* as the end form of this family because of the extremely large antorbital organs.

SUDIDAE, OMOSUDIDAE, ALEPISAURIDAE.—Regan (1911: 128) established the genus *Parasudis* for *Chlorophthalmus truculentus,* which differs from *Chlorophthalmus* in that the snout is produced so that the maxillary does not reach posteriorly to the eye. Regan places it at the mid-point between *Chlorophthalmus* and *Paralepis* but we have interposed *Sudis.* He notes, too, a similarity in mouth structure between *Chlorophthalmus* on the one hand and *Sudis* and *Paralepis* on the other, for while the maxillary is more slender and more adherent to the premaxillary, it is somewhat dilated distally and bears a long supramaxillary as in *Chlorophthalmus.*

Sudis bronsoni, which follows *Parasudis* in our chart, is very similar except that the anal fin is longer and the dorsal and pelvics have moved posteriorly. At the same time the characteristic gape of *Parasudis* is maintained. It is from some such comparatively undifferentiated group as *Sudis* that the Omosudidae and Alepisauridae have been derived (Parr, 1929).

Parr (1929) in his excellent paper on the osteology and classification of the Iniomi, pointed out that the " . . . line of differentiations leading from *Chlorophthalmus* through *Bathysudis* to the Omosudidae is characterized by a strong reduction of the lateral ethmoids, with a complete obliteration of their transverse process and a corresponding shifting forward of the main attachment of the palatines to the naso-ethmoidal region. Further, by the reduction of the suborbital bones and by the anterior fusion of the nasals with the mesethmoid. The parietals remain separate. The posterior temporal fossae are entirely unroofed. There is no orbitosphenoid and the basisphenoid is absent or reduced to a mere vestigial ossification. In all these respects the Omosudidae show a perfect continuation of the series already started by the genus *Bathysudis*" (*Lestidium* on our chart). There is no doubt that *Bathysudis* has been derived from *Chlorophthalmus* through *Sudis* for externally at least they are very similar with regard to gape, fins and general body form. Parr (*op. cit.*: 5) believed, too, that the scale-bearing genus *Sudis* is an intermediate stage between the equally scale-bearing genus *Chlorophthalmus* and the naked *Bathysudis.*

Sudis, as well as giving rise to the Omosudidae, has, by a process of elongation, apparently given rise also to the Alepisauridae. The first figure showing this tendency on our chart is a member of the same subfamily, *Paralepis borealis,* which is merely a greatly elongated form of *Sudis.* The representative of the Alepisauridae we have figured, *Alepisaurus ferox,* is characterized externally by an enormously large dorsal fin running from just behind the head almost to the posteriorly placed adipose fin; otherwise it is quite similar to *Paralepis.*

SCOPELARCHIDAE and EVERMANNELLIDAE.—Parr (1929: 5) gave the points which are common to *Scopelarchus* and *Evermannella.* The suborbital bones of both are strongly developed; a posteroventral production of the infraorbital along the upper margin of the maxillary has appeared; the

lateral ethmoids and their transverse processes for attachment of the palatines are well developed throughout the series; the nasals remain entirely separate from the mesethmoid and are attached to the frontals only by ligament and (apparently unique among the Iniomi) the parietals have become completely fused to the frontals. Parr (*op. cit.:* 7) believed that the well-developed roof over the anterior parts of the posterior temporal fossae is a "fundamental difference" between these families and the other Iniomi.[1] He further believed the scale bearing *Scopelarchus* to be more primitive than the naked *Evermannella*. While Parr hesitated to proclaim the Aulopodidae as the ancestral family to the group, he regarded the Scopelarchidae and Aulopodidae as more closely related than are the Scopelarchidae and the Sudidae. We have no hesitation, however, in deriving the Scopelarchidae from an *Aulopus*-like form of some sort.

CETOMIMIDAE.—*Cetomimus* is a peculiar-looking fish with an enormous head and mouth which give it a vague resemblance to the right whales. The family was believed by Parr (1929: 8) to show "similar fundamental phylogenetic tendencies as those expressed in the skeletal structures of the Scopelarchidae." The two families are in accord in having the parietals fused with the frontals and in having the lateral ethmoids well developed, with prominent transverse processes serving as the main support and attachment of the palatines. On this basis we have figured it close to the Scopelarchidae and have suggested on the chart its derivation from an *Aulopus*-like form.

DISCUSSION AND SUMMARY

The Iniomi tend to be like primitive acanthopteroids with the ventral fins beneath the pectorals, elongate premaxillae excluding the maxillae from the gape; the primitive forms (*Sardinioides*) have the first few rays of the dorsal fin unjointed. Thus these fish contrast widely with the deep-sea isospondyls in essential characters. In habitus characters there are frequent parallels in details, but rarely in the body as a whole.

We conceive the most primitive among the known Iniomi to be the genus *Aulopus,* which may have been derived from the still more generalized Upper Cretaceous *Sardinioides* by moderate elongation of the body and anal fin and marked elongation of the dorsal fin. The skull structure is fundamentally the same as in *Sardinioides* except for greater elongation of the cranium and other proportional differences. From the central *Aulopus*-like type divergent evolution occurred as follows:

1) Through *Saurus* to *Bathysaurus*. Pike-like, with large forwardly pointing mouths and very slender maxillae.
2) Macrurid-like derivatives (Ateleopodidae) with excessively elongate anal and feather-like dorsal. Pelvics elongate, in front of pectorals.
3a) *Chlorophthalmus* to *Bathypterois*. Eyes at first enlarged, subsequently reduced to uselessness. Correlated development of "feelers" from the rays of pectoral and pelvic fins.

[1] Later in the same paper Parr contradicts his own statement that the posterior temporal fossae are roofed over in the Evermannellidae. He states definitely (p. 17) that they are *not* roofed over: " . . . the posterior temporal fossae are not roofed nor with a partial anterior roof formed by the squamosals and frontals."

3b) *Bathysauropsis* to *Ipnops*. Another side-line but with the body much elongate behind the dorsal fin and a blind end-form.
4) *Chlorophthalmus* to varied myctophids. At first without light organs.
5) *Chlorophthalmus* to *Alepisaurus*. The latter a giant predator with sail-like dorsal fin.
6) *Chlorophthalmus* to *Omosudis*. The end stage, with enormous jaws and teeth.
7) *Aulopus* to *Evermanella*. Paralleling *Omosudis* but differing widely in technical characters. Teeth barbed, eyes "telescopic" and directed upward. *Scopelarchus* is a side branch.
8) *Aulopus* to *Cetomimus*. Body secondarily shortened. Head somewhat whale-like.

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AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY.

A New Rock Bass from Louisiana and Mississippi[1]

By Percy Viosca, Jr.

IN a miscellaneous collection of fishes taken on May 19, 1935, near Covington, Louisiana, there were 18 specimens which obviously belonged to the genus *Ambloplites,* but which seemed to differ from *A. rupestris,* a species which I had never taken in the region of my ichthyological investigations, confined for the most part to southeastern and central Louisiana. The large thick head, large eyes, a depression in the frontal region, and conspicuous black markings in these specimens were very suggestive of a new find. They were critically examined during the weeks following their discovery by George H. Penn, Jr., and myself, and carefully compared with 4 specimens of *A. rupestris* sent to me by Dr. Carl L. Hubbs.

I am deeeply indebted to Mr. Penn for valuable assistance rendered in the critical examination of the specimens and preparation of the tables and to him and Karl E. Pottharst for assistance in gathering and preserving the collection; to Dr. Carl L. Hubbs for the examination of literature not available in New Orleans, for the identification of minnows and darters referred to herein, for reading and criticising the manuscript and for making a number of valuable suggestions. I am indebted also to Dr. J. G. Needham for the identification of insect fragments found in the stomachs examined and to Dr. Chancey Juday and C. L. Schloemer for the scale readings. National Museum specimens referred to were submitted to me for study through the courtesy of Dr. George S. Myers.

Specimen No. 11 of the collection has been selected for the holotype because it is a fair average of the type series and because the juvenile markings are not obscured as in older adults. The holotype has been presented to the United States National Museum and paratypes 3, 9 and 15 to the Museum of Zoology, University of Michigan. The 14 remaining paratypes are in the author's collection.

Ambloplites ***ariommus,*** sp. nov.

Holotype (Fig. 1).—U. S. Nat. Mus. No. 101305, collected in Little Bogue Falia Creek, 3 miles north of Covington, Louisiana, May 19, 1935; standard length 120 mm.; total length 147 mm.; depth 50 mm. (in length 2.40); head 47 mm. (in length 2.55); eye 15 mm. (in head 3.13); length of upper jaw 23 mm. (in head 2.13); thickness of head at cheeks 23 mm.; interorbital 11.67 mm. (in thickness of head at cheeks 1.97); greatest depth of caudal peduncle (between posterior ends of vertical fin bases) 20 mm. (in length 6.00); dorsal rays XI, 12; anal rays VI, 12; scales 6–40–13; cheek scales in 6 horizontal rows; lingual teeth in 1 patch; pyloric caeca 8; gill-rakers, 7 well developed, in addition to rudiments; profile concave above eye, humped at nape; mouth large, oblique; lower jaw projecting; maxillary large, reaching just beyond middle of eye; ground color, in life, olivaceous above, lighter below; irregular black blotches on the body, the largest com-

[1] A contribution of the Research Department, Southern Biological Supply Co., Inc., New Orleans, Louisiana.

bination forming a crescentic clouded area extending across the side from middle of base of dorsal fin to base of anal spines; each scale with a subtriangular dark spot, sometimes more or less obscured, these spots with their apices forward and connected by bands of somewhat lighter color into a series of dark stripes running the entire length of the body, more noticeable below than above the lateral line; fine black dots present on body scales throughout; unpaired fins with conspicuous, more or less vermiculate dark mottlings arranged in about 4 rows on dorsal and anal, and about 6 on caudal.

THE TYPE SERIES.—This consists of 17 paratypes in addition to the holotype. All were taken on the same day in the same portion of Little Bogue Falia Creek. A tabulation of measurements and ratio quotients and their averages for this series is compared with similar data for a series of 4 specimens of *A. rupestris* from Michigan (Table 1). The head in length and depth in length quotients are in fair agreement in the 2 species. The eye is large and somewhat protuberant in the new species and the eye in head quotient is smaller than in specimens of *rupestris* of the same size. The interorbital region is depressed, and although the distance between the eyes is somewhat less in the new species, the physiognomy of the head as a whole presents a wider and more "bull-headed" appearance than in *rupestris*. When the interorbital distance is expressed in the thickness of the head at the cheek region, there is a slight overlapping in the proportion for the two series, possibly because the latter measurement may be affected by the varying positions of the movable parts of the heads.

In *A. ariommus* the mouth is apparently both larger and wider than in *rupestris*, although these measurements are also difficult to determine. The upper jaw is longer in the new species, but, as the eye is also larger, the relation of the jaw to the orbit is about the same in the two species. In both, the maxillary reaches the middle of the eye in young specimens, and beyond this point in mature individuals. It is advisable, therefore, to compare the length of the upper jaw to a character which is more constant for the two species. This measurement expressed in the head length gives a different quotient for each species in different size groups. There is some overlapping due to age, however, in the 2 series; this figure in the young of *ariommus* is about the same as in adults of *rupestris*. The mouth becomes larger in the adults of both species.

The caudal peduncle is slenderer and less tapering in the new species than in *rupestris*. The greatest depth of the caudal peduncle (measured between the posterior bases of dorsal and anal fins) expressed in the length of the fish averages 5.99 in *ariommus* and 5.34 in *rupestris;* there is no overlapping in the 2 series.

The scale counts on the body differ but slightly, averaging about 6–39–13 for *ariommus* and 7 to 8–40–12 for *rupestris* in the specimens examined. There is considerable difference between the 2 species, however, in the squamation of the cheeks, nape and breast. On these areas the scales are smaller and their number about one-half greater in *rupestris* than in *ariommus;* the number of horizontal rows for *rupestris* exceeds the count for

ariommus by a substantial margin in each area. The number of horizontal rows of dorsal scales decreases near the base of the first spine; at this point the number in *rupestris* is only slightly higher than in *ariommus* due to a greater reduction in *rupestris*. Beyond this point the number of rows above the lateral line is practically the same in the 2 species, reaching a minimum

TABLE 1. MEASUREMENTS IN MILLIMETERS (IN PARENTHESES), QUOTIENTS INDICATING PROPORTIONATE SIZE OF PARTS, AND DORSAL AND ANAL FIN RAYS, IN THE TYPE SERIES OF *AMBLOPLITES ARIOMMUS* AND IN SPECIMENS OF *AMBLOPLITES RUPESTRIS* FROM MICHIGAN

Species	No.	Standard length (L)	Depth (D) and L/D	Head (H) and L/H	Eye (E) and H/E	Upper Jaw (J) and H/J	Thickness at cheeks (T)	Interorbital (I) and T/I	Caudal Peduncle (C) and L/C	Dorsal spines, and soft rays	Anal spines, and soft rays
Ambloplites ariommus	1	(49)	(21) 2.33	(21) 2.33	(8.5) 2.47	(9) 2.33	(8.5)	(4.5) 1.89	(8) 6.13	11, 11	6, 10
	2	(61)	(26) 2.34	(25) 2.44	(10) 2.50	(11) 2.27	(12)	(5.8) 2.07	(10) 6.10	11, 12	6, 11
	3	(63)	(26) 2.42	(26) 2.42	(10) 2.60	(12) 2.16	(12)	(6) 2.00	(10) 6.30	11, 11	6, 11
	4	(67)	(28) 2.39	(27) 2.48	(11) 2.45	(12) 2.25	(13)	(6.2) 2.09	(11.5) 5.83	11, 11	6, 12
	5	(80)	(33) 2.42	(32.5) 2.46	(11) 2.95	(15) 2.16	(16.5)	(7) 2.36	(13) 6.15	11, 11	6, 11
	6	(82)	(36) 2.87	(35) 2.34	(13) 2.69	(16) 2.18	(16)	(8) 2.00	(14) 5.86	11, 11	6, 11
	7	(94)	(41) 2.29	(37) 2.54	(13) 2.84	(17) 2.17	(17)	(7.67) 2.33	(16) 5.88	11, 11	6, 11
	8	(104)	(46) 2.26	(41) 2.53	(14) 2.92	(20) 2.05	(20.5)	(9.67) 2.12	(17) 6.12	11, 13	7, 11
	9	(106)	(45) 2.35	(41) 2.58	(15) 2.73	(19) 2.15	(21.5)	(9.67) 2.22	(18) 5.88	10, 13	6, 11
	10	(120)	(49) 2.45	(46) 2.61	(15) 3.06	(22) 2.09	(23)	(11) 2.09	(20) 6.00	11, 13	6, 11
	11	(120)	(50) 2.40	(47) 2.55	(15) 3.13	(23) 2.13	(23)	(11.67) 1.97	(20) 6.00	11, 12	6, 12
	12	(120)	(51) 2.37	(48) 2.50	(15) 3.20	(23) 2.08	(24)	(11.33) 2.12	(20) 6.00	11, 12	6, 11
	13	(127)	(54) 2.35	(49) 2.59	(16) 3.06	(23) 2.13	(22)	(10.67) 2.06	(20.5) 6.19	11, 13	7, 11
	14	(129)	(55) 2.34	(51) 2.53	(16) 3.18	(24) 2.12	(25)	(12.5) 2.00	(20.5) 6.29	11, 12	6, 11
	15	(132)	(56) 2.35	(52) 2.53	(16) 3.25	(24) 2.16	(26)	(11.5) 2.26	(23) 5.78	11, 12	6, 11
	16	(138)	(57) 2.42	(53) 2.60	(17) 3.11	(25) 2.12	(27)	(12) 2.25	(24) 5.75	11, 11	6, 10
	17	(139)	(60) 2.31	(57) 2.44	(18) 3.16	(27) 2.11	(27)	(14) 1.93	(24) 5.79	11, 13	6, 12
	18	(139)	(59) 2.35	(58) 2.39	(18) 3.22	(29) 2.00	(28)	(12.5) 2.24	(24) 5.79	11, 13	6, 12
	Ave.	....	*2.39*	*2.49*	*2.92*	*2.15*	....	*2.11*	*5.99*	*10.94,* *11.94*	*6.11,* *11.11*
Ambloplites rupestris	1	(66)	(30) 2.20	(27) 2.44	(8) 3.37	(11) 2.45	(13)	(6.67) 1.95	(12) 5.50	11, 11	6, 10
	2	(110)	(45) 2.44	(43) 2.55	(12) 3.58	(18) 2.38	(20)	(10) 2.00	(21) 5.24	11, 11	6, 10
	3	(111)	(43) 2.58	(45) 2.46	(12) 3.75	(20) 2.25	(20)	(11.67) 1.71	(20) 5.55	11, 11	6, 10
	4	(132)	(60) 2.20	(50) 2.64	(13) 3.84	(22) 2.27	(23)	(14) 1.64	(26) 5.08	12, 10	7, 8
	Ave.	....	*2.36*	*2.52*	*3.64*	*2.34*	....	*1.83*	*5.34*	*11.25,* *10.75*	*6.25,* *9.50*

of 5 or 6 rows. The total number of scales on the cheek in *ariommus* is about 100 or less as contrasted with about 150 in *rupestris*. They form about 5 or 6 horizontal rows as contrasted with about 8 in *rupestris*, when the count is made from the eye downward to the anterior border of the preopercle. In the character of the cheek scales as well as the larger mouth, the new species shows an analogy to the largemouth black bass, and *rupestris* to the smallmouth.

The spinous dorsal is shorter in *ariommus* than in *rupestris*, averaging about 1⅔ times the length of the soft dorsal in adults of the former and about twice as long in adults of the latter; this difference is not so marked in the young. The spines in *ariommus* are longer and stronger: the length of the spinous dorsal is only about twice the height of the longest spine in adults of that species, whereas in adults of *rupestris* this fin is nearly 3 times as long as high. In the young this ratio quotient is about 1.65 in *ariommus* and 2.0 in *rupestris;* in this character also the young of *rupestris* averages about the same as the adult of *ariommus*. The soft dorsal and anal rays average somewhat higher in number in the new species than in *rupestris* (Table 1).

The lingual teeth are usually in a single patch, but are in a double patch in 3 specimens of the series (Nos. 6, 10, and 12), and are absent in a single specimen (No. 15). The number of pyloric caeca is usually 7, rarely 6 or 8.

Color.—The predominant color in the new species, especially when viewed from above, is black. In preserved material this becomes brown with age. Although there is some variation among different individuals of the new species, the general ground color in life is olivaceous above, blending into straw or oyster white below; these lighter markings are overlain with and often obscured by black shadowy cloudings, spots and dots. Above the lateral line, the lightest shade between the black areas is olive drab,[2] and all scales in this region show metallic green reflections. On the sides the ground color is of a lighter olive (olive sheen) and here the reflections vary between greenish gold and old gold although a pearly iridescence of a bluish or pinkish cast appears from some angles to the light. On the lower part of the sides and on the belly, the lighter areas are generally straw color, but are as light as oyster white in some specimens. Here the iridescence is not so noticeable.

The pattern assumed by the black shadowy areas, although difficult to define, seems to be different from that of *rupestris*. On the new species the largest and most conspicuous combination of blotches is situated below the middle of the dorsal fin. This often consists of two subtriangular cloudings, the upper inverted and with its apex joining the apex of the lower triangle, the composite forming a roughly hour-glass shaped marking on the third quarter of the body. On some specimens this clouded area assumes a crescentic shape as in the specimen illustrated (Fig. 1). In others, smaller horizontal markings join the apices of the vertical triangles on either side, giving the figure the general appearance of an asymmetrical Maltese cross.

[2] The usage of color terms follows *A Dictionary of Color*, by Maerz and Paul, McGraw-Hill Book Co., New York, 1930.

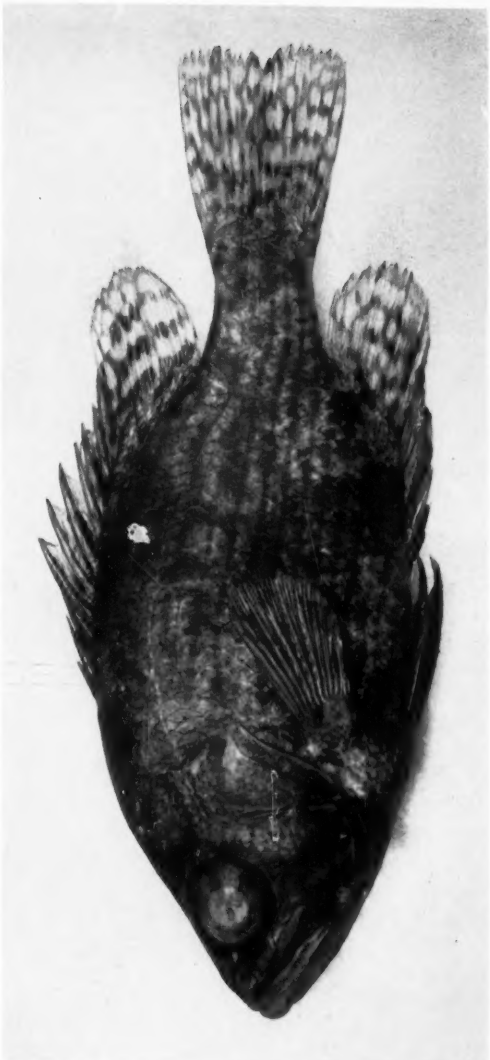

Fig. 1. The holotype of *Ambloplites ariommus* (retouched photograph), natural size.

Fig. 2. Little Bogue Falia Creek
(Further explanation on p. 41, opposite)

Fig. 3. Big Bogue Falia Creek
(Further explanation on p. 41, opposite)

On most individuals a black spot is discernible on each of the body scales. These spots are conspicuously subtriangular, with the apex forward, rather than subquadrangular as seems to be the tendency in *rupestris*. These spots with their connecting bars, although more or less obscured by the shadowy areas, often present the appearance of continuous longitudinal stripes rather than rows of squarish spots as in the northern species. In addition to the darker markings mentioned above, fine black dots appear on the body throughout, usually in greatest numbers on or near the edges of the scales, giving them a darkened outline.

The head is mainly black, especially the nose and upper jaw; the chin and lower jaw, oyster white with irregular black cloudings. The iris has two conspicuous brilliant scarlet areas, one in front of and one behind the black pupil. Above and below the pupil, the iris is nearly black, but silvery areas are sometimes present.

There are fewer dark bars on the unpaired fins than usually in *rupestris*. The dorsal and anal have about 4 rows and the caudal about 6 in the new species, whereas the dorsal and anal usually have about 6 and the caudal usually about 8 in *rupestris*. These appear more as a pattern of bars or vermiculations rather than as rows of spots as usual in the latter species.

Ambloplites ariommus is so perfectly camouflaged against the black stained logs and debris of its environment, especially in humus stained waters, that it is difficult to discern in the water except when it turns belly up. It possesses chameleon-like powers; a captive specimen may appear dark one instant, pale the next, and dark again a moment later. When assuming its darkest phase, the scarlet markings on the iris are obscured entirely by the black pigment, whereas the greatest brilliance of the eye is seen when the palest phase is assumed and the black pigment cells are contracted.

RELATIONSHIPS.—Only 2 species of *Ambloplites* are listed in the literature, *A. rupestris* (Rafinesque) and *A. cavifrons* Cope.[3] The latter has not been critically examined of late. From Cope's description, it would seem that the concave head and the large mouth and eye of *cavifrons* would ally it with *ariommus*. On the other hand, *cavifrons* shows a straight dorsal line from the cranium to the origin of the spinous dorsal, whereas *ariommus* is decidedly humped at the nape. Cope states further that in *cavifrons*, the spinous

[3] Jour. Acad. Nat. Sci. Phila., 1868: 217 (Roanoke River, Va., E. D. Cope).

Further explanation for Figs. 2 and 3

Fig. 2. *Little Bogue Falia Creek*, 3 miles north of Covington, Louisiana, the stream in which the type series of *Ambloplites ariommus* was collected. In the left foreground is a "deep" hole with many stumps, the habitat of the new species. A "making" bank to the right shows the sandy nature of the soil. The dense forest in the little valley consists of such trees as spruce pine, *Pinus glabra;* water oak, *Quercus nigra;* southern magnolia, *Magnolia grandiflora;* black willow, *Salix nigra;* black titi, *Cliftonia monophylla;* holly, *Ilex opaca;* river birch, *Betula nigra;* and many others.

Fig. 3. *Big Bogue Falia Creek*, 6 miles north of Covington, Louisiana, a typical Gulf Coastal Plain creek. In the left foreground is a sandbar and riffle area, in the distance, deeper water. The overhanging trees make fly fishing difficult. *Micropterus pseudaplites* is the dominant species in streams of this type, associated with *Xenotis megalotis* in the shallows and with *Ambloplites ariommus* in the holes.

dorsal is of the same length as the soft dorsal. In both *rupestris* and *ariommus* the spinous dorsal is considerably longer. The cheek scales on *cavifrons* are described as few and minute. On *ariommus*, although in fewer rows than on *rupestris*, the scales are larger than on that species and therefore still larger than on *cavifrons*. Cope states that *cavifrons* is silvery, with black points, and with narrow, vertical dark bars at the base of the body scales. Other differences or resemblances are not evident from Cope's description.

Bollman, in his review of the family,[4] states that *cavifrons* should probably be maintained as a distinct subspecies. He states, however, that "There is nothing peculiar or different in any respect from *rupestris* about the physiognomy of *cavifrons*, the sole tangible difference being in the scaling of the head."

Jordan and Evermann[5] say of *Ambloplites rupestris cavifrons* (Cope): "Scales on cheek minute and embedded, wholly invisible over most of the area; profile concave over the eyes. Differing in no other particular from *Ambloplites rupestris*. Roanoke River, Virginia."

It seems evident that the new *Ambloplites* is distinctly different from either *rupestris* or *"cavifrons,"* and that it deserves specific recognition. Because of the extremely large eyes, which are a notable distinction from all other members of the Centrarchidae, the name *Ambloplites ariommus* has been chosen for the scientific name. The term "southern rock bass" is suggested for the common name because of its generic significance and not because of any association with rocks as is the case with its northern congener. "Shadow bass" and "black goggle eye" [6] might have local significance where, because of the absence of rocks in the stream beds, the generic term would not be appreciated by the natives.

Ecology.—Comparatively little is known of the ecology of the new species. In the stream in which the type series was taken, and in similar streams, *Micropterus pseudaplites* is the dominant species. Other associates are *Xenotis megalotis, Fundulus notatus, Hadropterus nigrofasciatus, Notropis cercostigma, Notropis longirostris, Moxostoma poecilurum* and *Schilbeodes leptacanthus*.

Little Bogue Falia is a typical spring-fed Gulf Coastal Plain creek. It is about 15 to 20 feet across and usually not more than 4 or 5 feet deep in the holes. It is swift as such streams go, cutting a fairly deep gorge in its sandy valley. There are no rocks or gravel, but bars of coarse sand are numerous, and there is an abundance of old logs, stumps and fallen brush. There is little aquatic vegetation. The stream is a tributary of the Big Bogue Falia, a somewhat larger watercourse, which is in turn a tributary of the Chefuncta River. Swift and more or less similar at their headwaters, these streams all deepen and widen in the vicinity of Covington. Here they converge and the Chefuncta below the town is very sluggish, especially near its mouth where "tide water" [7] from Lake Pontchartrain has scoured a wide, deep channel,

[4] Rep. U. S. Fish. Comm. 16, 1888 (1891): 561.
[5] Bull. U. S. Nat. Mus., 47, 1896: 990.
[6] The term "goggle eye," which refers to *Ambloplites rupestris* in the North, is used in Louisiana and nearby states chiefly as a designation for the warmouth bass, *Chaenobryttus gulosus*.
[7] Changes in the direction and intensity of the wind have a far greater influence than true tides in causing fluctuating water levels in Lake Pontchartrain.

navigable for large steamships. In the sluggish portion of the system, *Micropterus pseudaplites* is replaced entirely by *Aplites salmoides;* there is a comparatively small stretch where the two occur side by side. Rarely does *Aplites* ascend the small swift tributaries, but frequently the channel cat, *Ictalurus punctatus,* occasionally the common mullet, *Mugil cephalus,* and often a few other species common in Lake Pontchartrain or the lower reaches of the river, ascend to the swifter portions of the tributaries.

TABLE 2. LIFE-HISTORY DATA FROM THE 8 LARGEST SPECIMENS OF *AMBLOPLITES ARIOMMUS* TAKEN IN BOLEY CREEK NEAR PICAYUNE, MISSISSIPPI, OCTOBER 27, 1935

No.	Standard length, inches	Total length, inches	Weight, ounces	Sex	Age in summers
1	6¼	7½	4½	♂	6
2	5⅞	7 1/16	4	♀	6
3	5⅜	6 9/16	3½	♀	5
4	5⅛	6¼	3	♀	5
5	5⅛	6¼	3	♂	5
6	5⅛	6¼	2¾	♀	5
7	4⅞	5 15/16	2½	♀	4
8	4 3/16	5⅛	1¾	♂	4

FOOD.—Stomach examinations of the 8 specimens of *A. ariommus* listed in Table 2 (part of a series of 14 taken in Boley Creek east of Picayune, Mississippi on October 27, 1935), throw some light on the habits of the new species: No. 1 contained 1 darter (*Hadropterus nigrofasciatus*), and fragments of a dragonfly nymph (*Macromia,* sp.), dytiscid (probably *Hydroporus,* sp.), stonefly nymph and adult leptocerid caddisfly; No. 2, 1 darter (*H. nigrofasciatus*), and fragments of a crawfish (*Cambarus* sp.); No. 3, 1 darter (*H. nigrofasciatus*); No. 4, 3 darters (1 *H. nigrofasciatus* and 2 of *Doration saxatile*) and fragments of a dragonfly nymph (*Macromia* sp.); No. 5, 1 darter (*D. saxatile*) and a small madtom (*Schilbeodes leptacanthus*); No. 6, fragments of a stonefly nymph (*Acroneuria* sp.); No. 7, nothing; and No. 8, 1 shiner (*Notropis longirostris*) and fragments of a dragonfly nymph (*Macromia* sp.).

It is seen that 4 stomachs showed insect remains, 6 contained fish, 1 included crawfish remains and only one was empty. All these food items with the exception of the adult caddisfly are bottom species, indicating that *ariommus* probably feeds on anything available in the deep holes. Two caterpillars representing 2 species were found in the stomach of a bluegill, *Helioperca machrochira,* taken on the same day, showing such insects to be active during a warm October and available to species feeding to a large extent at the surface. It may also be significant that there were no shiners of the species *Notropis cercostigma* in any of the stomachs of the new species,

although this is the predominant food form found in stomachs of *M. pseudaplites*. As *N. cercostigma* is very abundant in the shallows and riffles of Boley Creek, the absence of this species in the stomachs of *A. ariommus* would indicate an aversion to such areas. Its two chief game fish associates, *M. pseudaplites* and *X. megalotis*, are frequently seen resting and foraging in such areas, where the new species is never in evidence.

Ambloplites ariommus is apparently very secretive, hiding deep in the shadows. The large eye might indicate nocturnal feeding habits. That it is seldom taken and is practically unknown to anglers can be attributed only in part to the fact that most Louisiana anglers fish in large streams or in bodies of still water where the species is not found. Its game fish associates take the artificial fly readily and are well known to the angling fraternity.

SIZE AND AGE.—The series of specimens from Boley Creek shows a greater size range than the type series. In this lot there are specimens from 32 mm. to 159 mm. standard length. The last (a 6¼ inch specimen), the largest on record for the species, is a male weighing 4½ ounces. Table 2 gives the lengths, weights and the age in summers as determined by scale readings, for the 8 largest specimens of the Boley Creek series.

EDIBILITY.—*A. ariommus* can be rated as a first quality food fish, as its flesh is firm, flaky, of delicate texture and fine flavor. When compared at the same meal with 3 associated game species taken the same day in Boley Creek, fried specimens were judged to be of even more delicate flavor and of finer texture than either the bluegill, *Helioperca macrochira*, or the spotted bass, *Micropterus pseudaplites*. They were exceeded in flavor only by the long-eared sunfish, *Xenotis megalotis*.

DISTRIBUTION.—Dr. Carl L. Hubbs, after comparing specimens 3, 9 and 15 of the *ariommus* type series with material of *Ambloplites* from all parts of the range of *rupestris*, namely from Vermont, New York, New Jersey, Maryland, Virginia (James system), Ontario, Michigan, Wisconsin, Minnesota, Ohio, Indiana, Iowa, Missouri, northeastern Kentucky, West Virginia, Virginia (Tennessee system), Tennessee and northern Alabama, writes that he finds no match for, in fact not even a certain approach to the new species, even in the southernmost of these states. It seems evident, therefore, that *Ambloplites ariommus* is confined to the southern part of the Gulf drainage.

It may be predicted that the new species will be found to occur rather widely both west and east of the type locality, in spring-fed streams similar to those of the Chefuncta River system. I believe that I saw the species taken several years ago from Indian Creek near Forest Hill, in the Red River basin of south central Louisiana. Farther to the westward it should be searched for in Texas, southeastern Oklahoma and southern Arkansas. To the eastward it could be expected at least as far as Alabama and possibly northwestern Florida in the Gulf Drainage. The series of 14 from Boley Creek referred to on p. 43 as well as a single specimen taken in Bogalusa Creek on July 16, 1935, add the Pearl River system to the range of the new species. A specimen from Chickasawhay River, Mississippi, near the

Alabama border (Cat. No. 27451, U. S. National Museum), is unquestionably referable to the new species as are also 7 specimens from Tangipahoa River, Louisiana (No. 16919, U. S. Nat. Mus.). On the other hand, a specimen of *Ambloplites* from Ogechee River, Savannah, Georgia (No. 114, U. S. Nat. Mus.) and 5 specimens from Waynesville, North Carolina (No. 42431, U. S. Nat. Mus.) are not referable to the new species. The National Museum specimens from North Carolina (French Broad system) agree in proportionate measurements with *rupestris*, while those from Mississippi and Louisiana agree with *ariommus*. The squamation of the cheeks, nape and breast, the characters of the dorsal fins, and the physiognomy of the Louisiana and Mississippi specimens, are definitely characteristic of *ariommus*. The specimen from Ogechee River shows differences which may be of regional significance, but the material is insufficient to throw light on the *cavifrons* problem.

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The Mechanism of Internal Fertilization in *Gambusia*

By Albert Collier

AMONG the ovoviviparous fishes, there are perhaps none quite so interesting as those of the order Cyprinodontes. Certain genera within the order, comprising the family Poeciliidae, exhibit a striking sexual dimorphism associated with internal fertilization, manifested externally in the elongated anal fin or gonopodium of the male, internally by various modifications in the skeletal and urogenital systems and associated structures. It is the purpose of this paper to present a study of the structure and function of the anal fin and associated parts in *Gambusia affinis affinis* (Baird and Girard), which appears to have one of the more highly specialized types of apparatus for effecting internal fertilization.

The highly modified structures of the anal fin and its supports in the male *Gambusia* has attracted considerable attention. In their extensive morphological works on *Gambusia* Ryder (1886) and Kuntz (1913) chiefly treated the embryology of the fish, giving only secondary consideration to the reproductive system. Philippi (1908) began a monographic work on the morphology of the ovoviviparous Cyprinodontes, and worked out the details of structure in two species which he erroneously referred to *Glaridichthys*, but those species are not sufficiently similar to *Gambusia* in respect to the male reproductive system to throw much light on the latter genus. Langer's (1913) paper, supplementing the work of Philippi, dealt with the ovoviviparous Cyprinodontes in general, but treated *Gambusia* in a rather superficial manner. Poey (1854) and Garman (1895) long ago had figured these structures in *Gambusia*. Regan (1913), Geiser (1923), Hubbs (1926),

and other recent workers have described and figured the gonopodium of *Gambusia* in detail. Potter and Medlen (1935) briefly described the urogenital system of *Gambusia patruelis (= G. a. affinis)*.

In the present work a detailed study has been made of modifications of the anal fin mechanism, and also of certain modifications of the urogenital system. An attempt will be made to correlate peculiarities of these systems with the method of insemination which is believed to be employed by *Gambusia*.

The studies reported in this paper were made entirely on one species of fish, *Gambusia affinis affinis* (Baird and Girard), collected on the Rice Institute campus from a drainage canal in which the species is constantly present in abundance. Only adult fishes were used in the work; no attempt was made to trace the embryological development of the sexual modifications observed.

The skeletal structures were studied by a staining method described by Marie P. Fish (1932), and by dissection under a binocular microscope. The urogenital system was studied by micro-dissection and serial paraffin sections.

The author wishes to offer his grateful acknowledgments to Dr. Asa C. Chandler for much encouragement and numerous helpful suggestions, and to Dr. Carl L. Hubbs for advice regarding certain of the terms used.

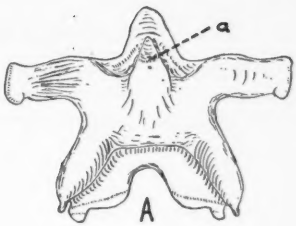
The Gonopodium or Modified Anal Fin

The short 1st and 2nd rays of the fin have a normal appearance. The 3rd, 4th and 5th rays are elongated to about one-third the standard length of the body, and are characteristically armed with recurved spines, serrae and hooks at the extreme distal end (Fig. 1). A less conspicuous, but probably significant modification is exhibited by the 6th and 7th, and sometimes the 8th rays, which are deeply bowed and separated by an unusually broad expanse of fin membrane to form a broad, deep concavity into which the spermatozeugmata (ellipsoid sperm masses) are probably transferred. There are no ducts in the 3rd, 4th and 5th rays, but these rays fold to form a trough along which the sperm is supposed to be transferred to the spiny tip of the gonopodium (Kuntz, 1914: 185; Potter and Medlen, 1935: 309). The spermatozeugmata are probably moved unbroken along this trough, to be held by the hooks to the tip of the gonopodium, for the observations of Philippi (1908: 31–33), abstracted by Henn (1916: 101–102), indicated that these sperm masses of poeciliids remain intact in physiological salt solution, but dissolve quickly in the ovarian fluid. Since microscopic observations have shown that sperm are active swimmers, it is possible that they make their own way up the ovarian duct.

The transfer of sperm, perhaps in one spermatozeugma, presumably takes place during the momentary contact of the gonopodial tip with the oviducal opening. As in other poeciliids, the male *Gambusia* faces forward and swings the gonopodium forward during the brief sexual contact, according to the obviously careful observations by Seal (1911). Ryder's often quoted, second-hand statement (1885) that the males of *Gambusia* head in opposite directions during copulation was obviously erroneous.

FIG. 1

FIG. 2



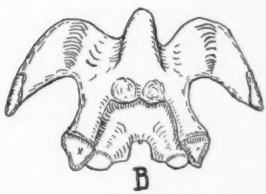


FIG. 4

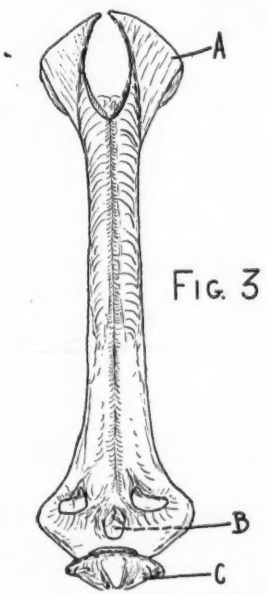


FIG. 3

FIG. 5

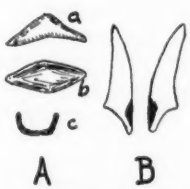


FIG. 6

FIG. 7

Figs. 1 to 7. Secondary sexual characters of anal fin and its supports in *Gambusia affinis affinis*.

Fig. 1. Distal tip of gonopodium of male.

Fig. 2. Pocket formed by the 5th to 7th or 8th anal rays of male. *A*, ventral, and *B*, lateral aspects.

Fig. 3. The compound interhaemal drawn from posterior face. *A*, the horseshoe-shaped cap; *B*, articulation for anterior articular process of 5th middle pterygiophore; *C*, articulation for distal pterygiophores.

Fig. 4. Fifth middle pterygiophore of male. *A*, anterior face; *B*, posterior face; *a*, anterior articular process.

Fig. 5. Fourth distal pterygiophore of male. *A*, anterior face, *B*, lateral face.

Fig. 6. Pterygiophores of female. *A*, 5th middle pterygiophore in *a*, lateral, *b*, ventral, and *c*, median section; *B*, 4th distal pterygiophore. Compare with Figs. 4 and 5. All pterygiophores drawn to same scale.

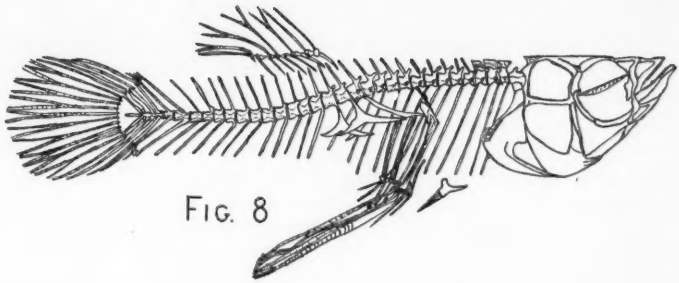
Fig. 7. Proximal pterygiophores (interhaemals) and middle pterygiophores of male. *A*, an interhaemal, *B*, diagram illustrating relationship of interhaemals and middle pterygiophores, showing *a*, interhaemal, and *b*, anterior articular process of middle pterygiophore *c*.

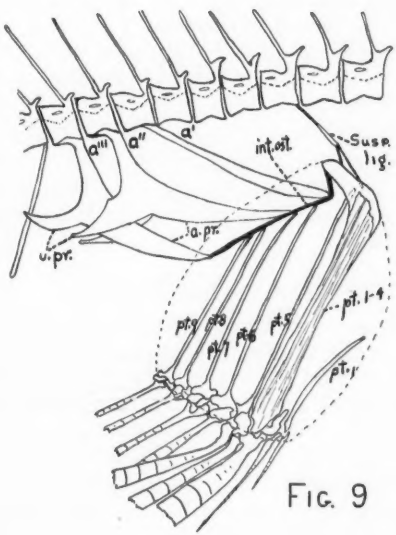
Supporting Elements of the Anal Fin

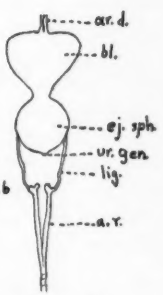
Complex anatomical specializations are developed to allow the complete reversal of the fin which takes place in coitus. Descriptions of these specializations with functional interpretations of them are attempted below.

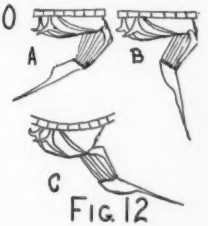
Pterygiophores.—In *Gambusia* and other poeciliids each fin ray articulates by means of two small bones, the middle and distal pterygiophores, with a slender bone, the proximal pterygiophore, or interspinal, which is entirely imbedded in the body musculature. In *Gambusia* males these bones are strikingly modified. The 2nd, 3rd and 4th ventral interspinals, or interhaemals, are fused to form a large truncated column, the compound interhaemal (Fig. 3), which bears an oblique horseshoe shaped cap, the ends of which may or may not meet to form a continuous rim. The ventral end of the compound interhaemal becomes broadened and fused with the 2nd, 3rd and 4th middle pterygiophores. The broadened base of the compound interhaemal formed by these fused bones provides an articular surface for the anterior articular processes of the 5th middle pterygiophore, and for the 3rd and 4th distal pterygiophores on its narrow tip. The remainder of the interhaemals, except the 1st, which is virtually normal except that it is bent forward as shown in the figures, show no striking modifications except in the ventral half of their length, where they become thin and broad, the broad portion being notched deeply as shown in Fig. 7A. The proximal and distal interspinals are characterized by a radical difference in shape (Figs. 4, 5 and 6). As noted above, the 2nd, 3rd, and 4th proximal interspinals are fused with the compound interhaemal. The 1st one is practically unmodified. The 5th to 9th are all similar in form, but decrease in size, and the function of each is the same, namely keeping unity of action among all the fin rays when the fin is reversed. This unity is accomplished by the insertion of the anterior articular process of each of these interspinals into the notch at the base of the preceding interhaemal. Fig. 7 illustrates this arrangement schematically. The 1st and 2nd distal interspinals show a slight tendency to modification, but the remainder all show a similar striking specialization in form. Fig. 5 represents the 4th distal interspinal, which is typical.

Haemal Spines.—The 1st haemal spine is simple, long, slender, and slightly bowed ventrally. It extends forward and terminates close to the proximal end of the compound interhaemal. The second haemal spine is suggestive of a bird's foot with 1 toe extended forward, and 2 shorter ones, the uncinatoid processes of Philippi (1908) and Langer (1913), extended backward; the anterior prong extends forward to a position approximately under the 4th to last abdominal vertebra, and the 2 posterior prongs terminate immediately under the third caudal vertebra. The 3rd spine is similar in structure to the 2nd, and a little more than half as large; its anterior prong extends to a point immediately below the last abdominal vertebra. The posterior prongs of these spines are anchored firmly in the body muscles which wall in the posterior portion of the cavity containing the air bladder. The reason for this arrangement is noted below. These haemal spines of









Figs. 8 to 12. Gonopodium and associated internal features of male *Gambusia affinis affinis*.

Fig. 8. Entire skeleton. Detail of skull omitted. See Fig. 9 for key to skeletal parts of anal fin.

Fig. 9. Skeleton of anal fin and associated parts. *a'*, *a''* and *a'''*, 1st, 2nd and 3rd gonapophyses; *u. pr.*, uncinatoid processes of 2nd and 3rd gonapophyses; *a. pr.*, anterior prongs of 2nd and 3rd gonapophyses; *int. ost.*, interosteal ligament; *susp. lig.*, suspensory ligament; *pt. 1* to *pt. 9*, interhaemals (proximal pterygiophores); *pt. 2–4*, compound interhaemal.

Fig. 10. Portion of compound interhaemal to show connections between its horseshoe-shaped cap, and the suspensory ligament, *a*.

Fig. 11. Bladder, ejaculatory sphere, and 5th anal ray. *ar. d.*, archinephric ducts; *bl.*, bladder; *ej. sph.*, ejaculatory sphere; *lig.*, ligament connecting ejaculatory sphere to 5th anal ray; *a. r.*, 5th anal ray; *ur. gen.*, urogenital opening.

Fig. 12. Series of diagrams illustrating method of reversal of anal fin in male. *A*, intrinsic muscles relaxed; *B*, same contracted; *C*, back arched.

the Poeciliidae which are modified as supports for the gonopodium form the gonapophyses of Philippi and Langer (Figs. 8 and 9).

Muscles and Ligaments.—The horseshoe-shaped head of the compound interhaemal provides attachment for two ligaments. The first of these, which I will call the interosteal ligament, originates at the anterior tips of the 2nd and 1st gonapophyses and then becomes attached to the posterior tip of the cap on the pterygiophoric column. The second ligament, arising from the mid-ventral surface of the centrum of the 4th from last abdominal vertebra, connects with a slender bone which may be considered as a part of the ligament, and which may also represent the remnant of a haemal spine. At the distal end of this bone the ligament divides into two branches, one branch passing to either of the inner surfaces of the horseshoe-shaped cap of the compound interhaemal (Fig. 10). This forked ligament, with the incorporated bone, may be termed the suspensory ligament. A third pair of ligaments serves to connect the ejaculatory portion of the urogenital system with the 5th anal ray as shown in Fig. 11. The function of these 3 ligaments is pointed out below.

The rim of the horseshoe-shaped head of the compound interhaemal serves as the origin of the intrinsic muscles operating the 3rd, 4th and 5th anal rays. These are extremely large and surround the compound interhaemal. Their bulk causes a swelling in the contour of the body easily visible on living specimens in aquaria.

Mechanism for the Reversal of the Gonopodium

Observations on the behavior of aquarium specimens show that the intrinsic muscles of the anal fin are able to carry this fin forward to a considerable extent, so that the angle between the axis of the urosome and the gonopodium is more than 90°. In copulation, however, the rays are carried forward to an angle of 140° to 150°. Due to the mechanical connections between the interhaemals and anal rays, this 40° to 50° extension of the arc made by the gonopodium would be impossible if the anal fin apparatus were as independent from the rest of the body as it usually is in other fishes. Consequently some extrinsic force is required to effect the complete reversal of the fin. Since there are no extrinsic muscles normally connected with the anal fin which would be capable of such action, this unique secondary function has been added to the primarily locomotor function of the body muscles. This secondary function in turn is made possible by the peculiar modification of the first 3 haemal spines, the gonapophyses, as already described.

It is evident that the extrinsic force necessary to complete the reversal of the anal fin is derived from an often-observed arching of the back, very sharp forward, which is always simultaneous with the reversal of the fin. Fig. 12 is a simplified diagram to show the action exerted on the fin by this nuptial arching of the back. A illustrates the condition with the intrinsic muscles of the anal relaxed, and B shows the position of the fin with the muscles contracted; C shows the completion of the reversal of the fin by the application of the extrinsic force derived from the nuptial arching of the vertebral column. This should make clear that the anal fin reaches its final

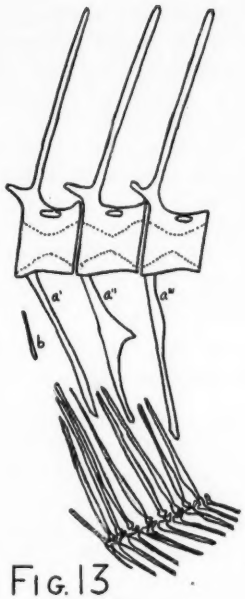


FIG. 13

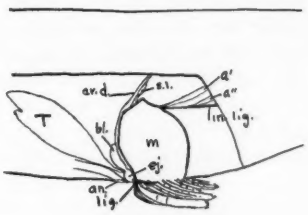


FIG 14

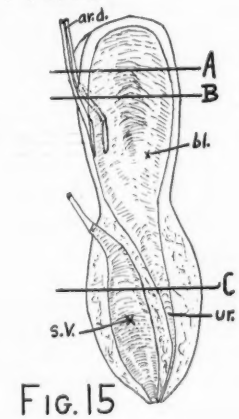


FIG. 15

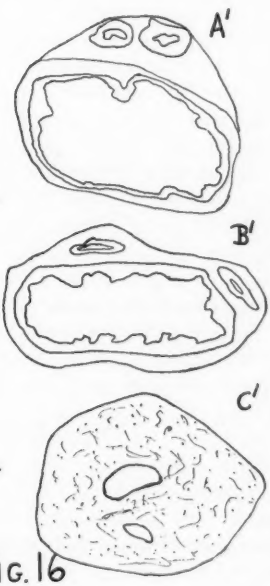


FIG. 16

Figs. 13 to 16. Internal structures related to sex in *Gambusia affinis affinis*.

Fig. 13. Skeletal system of anal fin in female. *a'*, *a''*, *a'''*, 1st to 3rd haemal spines (gonapophyses in male); *b*, homologue of bone in suspensory ligament of male. Compare with Fig. 8.

Fig. 14. Diagram to show relationships of various parts in male reproductive system. *T*, testis; *ar. d.*, archinephric ducts; *s. l.*, suspensory ligament; *a'*, *a''*, portions of 1st and 2nd gonaphyses; *in. lig.*, interosteal ligament; *m.*, large body of muscle surrounding interhaemals; *ej.*, ejaculatory sphere.

Fig. 15. Diagrammatic longitudinal section of bladder and ejaculatory sphere. *ar. d.*, archinephric ducts; *bl.*, bladder; *s. v.*, seminal vesicle; *ur.*, urethra.

Fig. 16, *A'*, *B'*, and *C'*. Cross sections taken at levels *A*, *B*, and *C* of Fig. 15.

stage of reversal by being pulled over by the compound interhaemal, which in turn is pulled back by the interosteal ligament. It can be seen that the effect of the arched vertebral column is to shorten the interosteal ligament.

The 3rd gonopophysis serves as the primary anchorage for the interosteal ligament, while the 2nd and 1st serve to shorten the ligament by taking up the slack. The uncinatoid processes of the 2nd and 3rd spines, the tips of which are imbedded in the body musculature, function as braces for the anterior prongs of their respective gonopophyses.

The suspensory ligament takes no part in this action; it seems to keep the compound interhaemal from sliding too far forward while the anal fin is at rest, or during normal swimming activities. This is necessary because the interhaemals are free in the foreshortened body cavity of the male.

Rudimentary Development in Female of the Secondary Sexual Modifications of the Male

Some of the special anal fin and osteological modifications of the male *Gambusia* are represented in vestigial or rudimentary conditions in the female. The anal fin of the female shows a distinct approach toward that of the male, especially in the 3rd, 4th and 5th rays. These rays are broadened near their proximal ends and otherwise approach the corresponding rays of the male, but they are only about half as long and bear no trace of hooks or spines.

The most striking reflection in the female of the special modifications of the male is found in the 2nd haemal spine. This spine consistently shows rudiments of the posteriorly directed uncinatoid processes and a slight bending forward of the lower portion of the spine (Fig. 13), clearly indicating the mode of formation of the tri-pronged gonopophyses in the male. The 3rd spine also frequently shows median bulgings, suggestive of the development of the uncinatoid processes of this gonopophysis. Just anterior to the first haemal spine in the female there is a small unattached bone which may be homologous with the small bone in the suspensory ligament of the male.

The Male Urogenital System

The male excretory and reproductive systems of *Gambusia* (Fig. 14) are more closely related than is usual in teleost fishes. The archinephric ducts pursue their usual course from the kidneys to the bladder, but here the system departs from the conventional arrangement. The bladder is combined with the ejaculatory mechanism to form an hourglass-shaped structure. The bladder forms the top part of the hourglass; the combined ejaculatory vesicle and urethra form the lower part. The bladder is penetrated near the top by the archinephric ducts which enter diagonally through the wall as is usual, so that the back flow of urine is prevented. The bladder (Figs. 15 and 16) becomes sharply constricted into a narrow duct at a point corresponding to the constriction of an hourglass. Here the vas deferens enters from the testis and becomes bound in with the urethra by a thick investment of loose areolar connective tissue containing some elastic fibres. As the two ducts proceed downward side by side, the urinary duct becomes

smaller, while the genital duct becomes somewhat bulged (Figs. 15 and 16). This ejaculatory portion of the system, or ejaculatory sphere, is connected with the 5th anal ray by ligaments as mentioned in an earlier paragraph. These ligaments are probably the means by which the ejaculatory sphere is contracted so as to eject the spermatophores, when the anal fin is reversed. The reversal of the anal fin is commonly observed to precede coitus in various members of the Poeciliidae.

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Rice Institute, Houston, Texas.

Lampris regius (Bonnaterre), the Opah or Moonfish from the North Pacific

By F. Heward Bell and John Laurence Kask

THE capture of a moonfish, *Lampris regius* (Bonnaterre) off the coast of Alaska is believed to greatly extend the known range of this species in the northeastern Pacific. This fish was taken on long-line halibut gear of the halibut vessel *Bernice*, Captain Louis Sunde of Seattle, on September 21, 1935, 30 miles S. × E. ½ E. off Icy Bay, Alaska, approximately 59° 24′ N. Lat., 141° 42′ W. Long. The depth of water was about 125 fathoms. This specimen was caught at or above a depth of about 50 fathoms due to snarling of that portion of the gear by the glass floats of the buoy line.

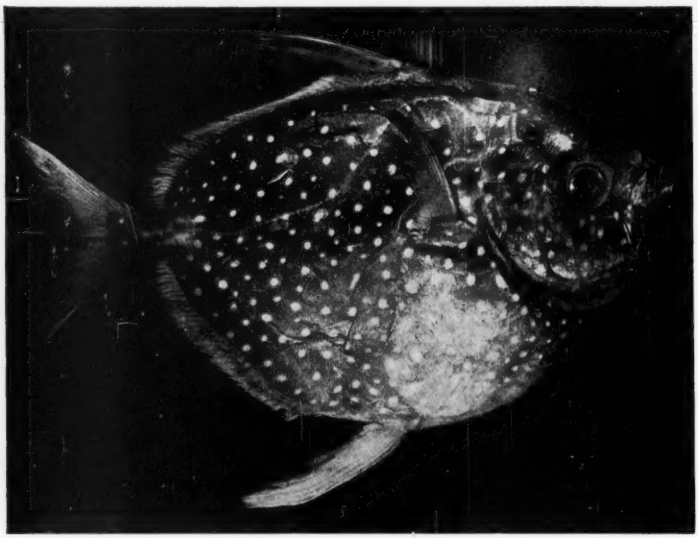

Fig. 1. Opah from off Icy Bay, Alaska.

The Alaska specimen showed five well-defined scars on the right side and one on the left resulting from the attachment of lampreys. The dimensions in mm. of the scars were as follows: right side, 17.0 × 17.5, 16.0 × 17.0, 14.0 × 14.0, 9.5 × 11.0, 9.0 × 10.0; left side, 7.0 × 8.5. In one of the smaller scars below the lateral line the impression of the teeth pattern was sufficiently clear to enable its definite identification as that of a specimen of *Entosphenus tridentatus*. No diagnosis was possible with the remaining scars except that the scar pattern of *E. tridentatus* was not suggested by the two larger scars showing above the lateral line.

Record is made of additional specimens of this species, each of which extends its original Pacific range. Richard T. Smith of the Washington State Fisheries Department gave to the University of Washington School of Fisheries a specimen caught September 9, 1935, 36 miles SW. of Cape Flattery, approximately 48° 11′ N. Lat., 125° 36′ W. Long. Another, which was given by Captain Andrew Nelson of the halibut vessel, *Tacoma*, was caught about October 1, 1935, 24 miles S. ½ W. off Cape Blanco, Oregon, approximately 42° 28′ N. Lat., 124° 51′ W. Long.

TABLE 1. COUNTS AND MEASUREMENTS OF *LAMPRIS REGIUS*
(All Lengths in Centimeters)

Univ. of Wash. Cat. No.	3717	3718	3719
Locality of Capture	Icy Bay, Alaska	Cape Blanco, Oregon	Cape Flattery, Washington
Date of Capture (1935)	Sept. 21	Oct. 1	Sept. 9
Length, total	51.3	56.3	51.4
Length, standard	49.0	53.7	48.7
Greatest depth of body	31.8	34.7	31.7
Weight, pounds	12.1	13.6	10.1
Weight, kilograms	5.5	6.2	4.6
Length of head	16.0	17.3	15.4
Length of maxillary	5.0	5.2	5.1
Diameter of eye, vertical	4.2	4.0	3.4
Diameter of eye, horizontal	3.9	3.8	3.2
Length from snout to orbit	6.0	6.5	5.6
Length from snout to dorsal origin	25.4	26.5	23.5
Length from snout to pectoral insertion	17.8	19.8	16.1
Length from snout to ventral insertion	28.3	34.5	26.8
Projected interorbital space	6.5	7.5	6.3
Suborbital width	5.1	5.9	5.3
Length from pectoral base to dorsal origin	15.1	16.3	14.4
Length from pectoral base to top of arch of lateral line	11.5	13.0	10.8
Pores along lateral line	83	81	81
"Shoulder blade"[a] length	9.0	8.9	8.1
Top of "blade" dorsal to pectoral insertion	6.3	6.4	6.5
Least depth of caudal peduncle	3.0	3.6	3.3
Dorsal fin rays	48	48	49
Length of longest ray	13.3	16.4	16.7
Position of longest ray	1	1	1
Length of shortest ray	1.9	1.7	1.7
Position of shortest ray	13	15	14
Anal fin rays[b]	34	34	33
Length of longest ray	3.6	3.7	3.5
Position of longest ray	19	20	20
Length of shortest ray	2.4	2.2	2.2
Position of shortest ray	5	5	5
Pectoral fin rays	22	20	21
Length of first ray (longest)	13.3	14.9	14.2
Ventral fin rays	14	14	14
Length of first ray (longest)	16.9	19.6	19.2
Caudal rays	30	30	30
Total gill-rakers on first arch	14	14	14

[a] "Shoulder blade" refers to projecting flap of postcleithrum and supracleithrum.
[b] Last ray may have two to three branches from a single base, all of which were counted as one ray.

A specimen of opah weighing 18 pounds was caught on August 18, 1935, 20 miles S. of Lennard Island Light, approximately 48° 48′ N. Lat., 126° 09′ W. Long., on a brass salmon spoon at about 10 fathoms below the surface (Anonymous, 1935).

Gudger gives the European range as extending to Iceland, but there are records of its occurrence from Greenland, Murman Coast, and the White Sea (Ehrenbaum, 1901: 75).

Due to the relatively few Pacific descriptions of this species, the data in Table 1 are made available.

Attention is called to the small size of these specimens. According to Gudger (1930), the smallest specimen recorded anywhere was one 2.5 feet (76.2 cm.) long, reported by Valenciennes from the Mediterranean. Roule (1929) notes a specimen 53 cm. long as the smallest observed to that date. The anal fin ray counts of 33, 34 and 34 are without the range recorded by Jordan and Evermann but corroborate that of W. F. Thompson, questioned by Gudger (1931: 533). Some of the anal ray counts for European specimens diverge widely from those taken from the specimens at hand.

The fins of the fish after several days storage in ice appeared vermilion, the maxillary and pre-maxillary brick red. Silvery spots were distributed over the body in irregular rows following the general contour of the posterior and ventral region of the body. This pattern somewhat resembles that pictured by Gudger (1930), and by Saemundsson (1926) from Iceland, but Fowler's (1928) and many European figures differ appreciably. Fowler's sketch and description indicate a differently shaped anal fin than in the specimens at hand and those elsewhere described.

Thanks are extended to Dr. Leonard P. Schultz of the University of Washington School of Fisheries for placing specimens 3718 and 3719 at our disposal.

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Ichthyological Notes

NOTE ON *COREGONUS* (*PROSOPIUM*) *CYLINDRACEUS* (PALLAS).—This very characteristic whitefish is known in Eastern Siberia as valyok, i.e., cylinder, *inde nomen*, which brings to mind the name "round whitefish" given locally in North America to *Coregonus* (*Prosopium*) *quadrilateralis* Richardson, usually known as "pilot" or "menominee." These two fishes are indeed very much alike.

There is in Siberia, and in the Old World generally, but one representative of the subgenus *Prosopium*, namely *C. cylindraceus*, the synonymy of which is as follows:

Coregonus (*Prosopium*) *cylindraceus cylindraceus* (Pallas)

Salmo cylindraceus Pallas, in Pennant, Arctic Zoology, 1, 1784: CIII (in part: Lena, Indigirka, Kolyma).

Salmo microstomus Pallas, Zoographia Rosso-asiatica, 3, 1811: 405 (in part: Lena, Indigirka, Kolyma).

Coregonus mongolicus Varpakhovskii, Ann. Mus. Acad. Imp. St.-Pétersb., 5, 1900: 424, pl. 13, fig. 2 (basin of upper Yenisei River).

Coregonus cylindraceus Berg, Poissons des eaux douces de l'URSS, 1, 1932: 219 (in part: Kolyma, Lena, Khatanga, Taimyr, Piassina, right tributaries of Yenisei), figs. 166a–c on p. 208 (Kolyma R.); *ibidem*, 2, 1933: 846. Awerinzew, Intern. Rev. ges. Hydrob. und Hydrogr., 32, 1935: 60 and 73 (lower course of Lena R.).

Coregonus lavaretus pidschian natio *mongolicus* Berg, *ibidem*, 1, 1933: 257, fig. 204.

Lateral line, $89\frac{8\text{-}11}{7\text{-}9}106$, average 97. Gill-rakers usually 18 to 20. From the right tributaries of the Yenisei to Kolyma.

Coregonus (*Prosopium*) *cylindraceus quadrilateralis* (Richardson)

Salmo cylindraceus Pallas, in Pennant, *l.c.*, 1784: CXXVII (in part: "Kamchatka").

Salmo microstomus Pallas, Zoographia Rosso-asiatica, 3, 1811: 405 (in part: Anadyr, Okhota, Kukhtui, "Kamchatka").

Coregonus quadrilateralis Richardson, in Franklin, Narrative of a journey to the polar sea, 1823: 714, pl. 25, fig. 2 (small rivers about Fort Enterprise and in the Arctic Sea).

Prosopium quadrilaterale Koelz, Bull. U. S. Bur. Fish., 43 (2), 1927 (1929): 544 (Great Lakes except Erie; Lake Nipigon), fig. 30 (Lake Huron).

Coregonus cylindraceus Kaganowsky, Fishes of the Anadyr River, in press (Anadyr and southward to the Vivenskaya River at 60° N. Lat., near Korf Bay; Penshina River, at Penshino). Berg, Poissons des eaux douces de l'URSS, 1, 1932: 219 (in part: drainage of the Pacific in Asia).

According to Koelz (1927) the number of scales in the lateral line in numerous specimens from the Great Lakes and Lake Nipigon is (74) 84 to 95 (100), and the number of gill-rakers is usually 16 to 18; both averaging somewhat fewer than in typical *cylindraceus*. So far as known these are the only differences between *cylindraceus* and *quadrilateralis*. In a subspecies more recently recognized by Koelz[1] from inland lakes of North America, named *Prosopium quadrilaterale minor*, the lateral line scale variation is given as 79 to 98, with an average lower even than in typical *P. q. quadrilaterale* as defined by Koelz.

A. G. Kaganowsky presented to the Museum of Zoology, Academy of Sciences, Leningrad, a specimen of *C. cylindraceus*, caught by him in the Anadyr at Ust-Belaya on July 3, 1929; it has the lateral line $86\frac{8}{6\frac{1}{2}}88$ and the gill-rakers 18. I refer this specimen (Berg, 1932: fig. 166d on p. 208) to subspecies *quadrilateralis*. It is probable that all specimens of *C. cylindraceus* from the Pacific drainage of Asia must be referred to the same subspecies.

The detailed distribution of subspecies *quadrilateralis* seems to be: Anadyr and mainland of Asia southward to the vicinity of Korf Bay, Bering Sea, and perhaps to Dranka River, opposite Karaginsky Island, northeastern Kamtchatka; also the following tributaries to Okhotsk Sea: Penshina River, Kukhtui River and Okhota River near Okhotsk; from Alaska to Great Lakes and New England.

The occurrence of a North American form in northeastern Siberia is not unique among true freshwater fishes. Besides *Coregonus cylindraceus quadrilateralis*, the follow-

[1] Pap. Mich. Acad. Sci., Arts and Letters, 13, 1930 (1931): 382.

ing species may be mentioned as having such a distribution: *Thymallus arcticus signifer* (Richardson 1823) = *Thymallus arcticus pallasi* Valenciennes, 1848, included on the basis of the still unpublished investigations of A. N. Svetovidov, Institute of Zoology, Academy of Sciences; *Coregonus nasus* (Pallas); *Catostomus catostomus rostratus* (Tilesius), and *Dallia pectoralis* Bean.

Coregonus nasus is represented in the Athabaska River by *C. nasus canadensis* Berg (Poissons des eaux douces de l'URSS., 1, 1932: 222), a form differing from typical *nasus* in having more gill-rakers, 26 or 27 (in *nasus* 19 to 25), and fewer scales in the lateral line, 81 to 83 (in *nasus* 85 to 105). Found in Beauvert Lake, Athabaska River, by A. Bajkov (Contributions to Canadian Biology and Fisheries, 3, 1927: 394).—Leo S. Berg, *Institute of Zoology, Academy of Sciences, Leningrad, U.S.S.R.*

ON THE SYSTEMATICS AND DISTRIBUTION OF THE GENUS *AGONUS* BLOCH AND SCHNEIDER.—The genus *Agonus*, established in 1801 by Bloch and Schneider in their *Systema Ichthyologiae*, was based on four species, of which only two Atlantic species, *Agonus cataphractus* and *Agonus decagonus* (erroneously referred to "India orientalis"), are closely allied. A third species of the same group was described in 1811 by Tilesius from Unalaska in the Pacific, as *Agonus acipenserinus*.

Theodore Gill in his short and preliminary revision of the family Agonidae in 1861,[1] without much comment upon his motive referred each species known at that time to a special monotypic genus, thus creating 4 closely allied genera: (1) *Leptagonus*, for *Agonus decagonus* Bloch and Schneider = *Aspidophorus spinosissimus* Krøyer; (2) *Agonus*, for *Agonus cataphractus* (Linnaeus); (3) *Paragonus* for *Agonus acipenserinus* Tilesius, and (4) a new genus *Podothecus* for a presumably new species, *Podothecus peristethus* Gill (*op. cit.*, p. 258).

Jordan and Evermann in their *Fishes of North and Middle America* (3, 1898) indicated that *Podothecus peristethus* Gill is identical with *Agonus acipenserinus* Tilesius, referred by Gill to the special genus *Paragonus*, but they maintained the generic name *Podothecus* for this species and for some new Pacific species of their own. Gill's monotypic genera *Agonus* and *Leptagonus* were left unchanged by these authors. No real revision of this group has since been undertaken. The three closely allied genera, *Agonus*, *Leptagonus*, and *Podothecus*, have been retained in most subsequent systematic lists.

Comparing now the representatives of these three genera, I come to the conclusion that they form a single, very natural generic group, with varying characters intermingled in such a way in different species as to preclude the possibility of subdividing it into well characterized genera or even subgenera.

According to the general shape and structure of the body and head two types can be distinguished: one with an elongate body, compressed head and subvertical cheeks, with a long snout and two large groups of barbels below, is represented by *Podothecus gilberti* (Collett) (= *P. accipiter* Jordan and Starks = *P. hamlini* Jordan and Gilbert), *P. acipenserinus* Tilesius and *P. veternus* Jordan and Starks (not seen by me, known from one specimen); the second type with a shorter and lower body, a larger, wider and depressed head, with sloping cheeks, with a shorter snout and some fewer and shorter barbels below, embraces *Podothecus thompsoni* Jordan and Gilbert and *Agonus cataphractus* (Linnaeus). But *Leptagonus decagonus* (Bloch and Schneider) forms an intermediate type, connecting these extreme groups. It has an elongate body and a smaller, somewhat depressed head, a very short snout and no barbels at all below. The development of barbels is obviously connected with the length of the snout and can hardly be regarded as a satisfactory generic character: the long-nosed *Podothecus gilberti* has two very large groups of barbels, while *Podothecus thompsoni* with a shorter snout (as also apparently *Podothecus veternus*) has fewer and smaller ones, and *Agonus cataphractus*, having a snout reduced to almost the same degree as in *Leptagonus decagonus* shows only a pair of barbels before the mouth.

The spines on the plates of the body are well developed in representatives of the first type and are strong and sharp also in *Podothecus thompsoni*, while the plates of *Agonus cataphractus* are even, without spines; but *Leptagonus decagonus* is also inter-

[1] Proc. Acad. Nat. Sci. Phila., 13, 1861: 77, 167.

mediate in this character, as it has short and blunt spines only on the posterior part of the body; its anterior part is covered with smooth plates.

The presence of barbels on the gill-membranes of *Agonus cataphractus* can hardly be regarded as a generic character, taking in consideration that generally the number and distribution of barbels is highly variable in this group of Agonidae.

The near relationships of *Agonus cataphractus* with *Podothecus thompsoni* was recorded by Jordan and Evermann (*op. cit.*, p. 2061).

The characteristics given by Jordan and Evermann for these three nominal genera can convince no one that we are dealing here with separate well defined genera. They are mostly characters defining the species only. For example the genus *Leptagonus* is characterized as follows: "body tapering, depressed; head about 5⅓, depth 7½ to 9; width 6½ to 8 in total length . . . teeth on both jaws, probably none on vomer and palatines . . . ."

After several unsuccessful attempts to divide this group into natural and well separated genera, I am proposing now to unite all three genera, thus restoring the old genus *Agonus* Bloch and Schneider, in the broad sense. We then have a very natural, closely connected, graded series of species: *Agonus acipenserinus* Tilesius→*Agonus gilberti* Collett→*Agonus veternus* (Jordan and Starks)→*Agonus decagonus* Bloch and Schneider→*Agonus thompsoni* (Jordan and Gilbert)→*Agonus cataphractus* Linnaeus.

Only the last named species is strictly bound to the Atlantic, and even it may occur in Bering Sea. We have had in our Museum since the beginning of 19th century a specimen of *Agonus cataphractus* labelled "Kamchatka." Although this label is not very trustworthy, the possibility is not excluded that a more thorough investigation of the Pacific ichthyofauna will show that this species occurs in Bering Sea. *Agonus decagonus* was until recently also unknown in the Pacific, but in 1930 Soldatov and Lindberg in their "Review of the fishes of the seas of the Far East" recorded *Leptagonus* [=*Agonus*] *decagonus* from the northern part of the Bering Sea, and mentioned a doubtful finding of this species in the Sea of Japan at De Castries Bay. In studying the fishes of the Okhotsk Sea, I find 3 specimens of this species from different parts of this Sea north of 52° N. latitude, in depths from 90 to 195 meters, and confirm the record for De Castries Bay. It may be regarded as settled that *Agonus decagonus* occurs in all three of our eastern seas of the North Pacific, as also in Kara and Barents seas, connected with the Atlantic.

Agonus acipenserinus occurs in our collections not only from the eastern, but also from the western part of the Bering Sea. *Agonus gilberti*, a species very near to the preceding and perhaps merely its western subspecies, is widely distributed in Okhotsk Sea and in the northern part of the Sea of Japan. It ranges to Petropavlovsk, but is replaced in Bering Sea by *A. acipenserinus*.—Peter J. Schmidt, *Academy of Sciences, Leningrad, U. S. S. R.*

PHAENOPOGON A SYNONYM OF *CIRRHIGALEUS*.—I regret to state that *Phaenopogon* Herre, and *Phaenopogon barbifer* Herre, published in Copeia, 1935 (3): 122–124, are synonyms of *Cirrhigaleus* and *Cirrhigaleus barbulifer* Tanaka.[1] My bound copy of Tanaka's papers does not contain volume 9, so that I overlooked Tanaka's prior description until my attention was called to it by Dr. George S. Myers who had just received a complete set of Dr. Tanaka's papers. My specimen is strongly differentiated from Dr. Tanaka's specimen, but the differences are due to sex and age.—Albert W. C. T. Herre, *Natural History Museum, Stanford University, California.*

OPSOPOEODUS EMILIAE FROM LAKE ST. CLAIR.—On July 6, 1935, I took two specimens of *Opsopoeodus emiliae* in a small artificial drainage cut opening into Mitchell's Bay, Lake St. Clair, near the village of Mitchell's Bay, Ontario. These specimens were identified by Dr. Hubbs, who informs me that they constitute a new northern record for the region. The northernmost locality in the Great Lakes region from which this species has previously been reported is in the vicinity of Monroe, Michigan. It penetrates somewhat farther northward along the Mississippi River.—K. H. Doan, *Department of Biology, University of Toronto, Toronto, Ontario.*

[1] Figures and Descriptions of the Fishes of Japan, 9, 1912: 151, pl. 41.

NOTE ON COLOR DIFFERENCES IN LIVING SPECIMENS OF TWO INDO-PACIFIC POMACENTRID FISHES, *DASCYLLUS TRIMACULATUS* AND *DASCYLLUS ALBISELLA*.—Since the description of the Hawaiian *Dascyllus albisella* by Gill in 1862, this species has generally been regarded as distinct from the wide-ranging *D. trimaculatus* (Rüppell), which does not reach Hawaii. The two species are very closely related, however, and Jordan and Evermann[1] do not seem certain that the two are really different. Recently it has been supposed[2] that *albisella* is a synonym of *trimaculatus*. Observation of many living specimens in the Shedd Aquarium makes me feel quite certain that *D. albisella* and *D. trimaculatus* are distinct species. Last spring I personally collected about 800 specimens of *albisella* at Kaneohe Bay near Honolulu, while my assistant, Mr. Brunskill, collected about 200 of *trimaculatus* at Suva, Fiji. Many individuals of *albisella* are still living in the Shedd Aquarium.

In life, the membranes of the vertical fins in *trimaculatus* invariably show a bronze coloration and the sides of the body occasionally have a bronze glint similar to that seen in the "Black Moor" variety of fancy goldfish. No specimen of *albisella* that I have ever handled showed any trace of this bronze coloring. The white spot on the side of *albisella* is larger in proportion to the body than that on *trimaculatus* and tends to increase in size as the specimen grows older. Also the scales on the sides in the area surrounding the white spot in older specimens of *albisella* have light blotches in the center, giving the sides a grayish appearance. At night, or when near death, these fish are apt to turn grayish white over the whole body.

The nuchal spot in *albisella* disappears in most specimens when the fish is about 1¼ to 1½ inches long. I have never seen a *trimaculatus* of any size which lacked the nuchal spot. The spot on the side of *trimaculatus* is always sharply defined; it is smaller and placed higher than that of *albisella*. The scales in the area surrounding the nuchal spot of *trimaculatus* are always black. Sometimes they show a bronze glint, but never the whitish markings seen in *albisella*. A comparison of the photograph of *albisella* in the Shedd Aquarium guide book[3] with Mr. Innes's[4] photograph of *trimaculatus* will show up the differences between these two species.—WALTER H. CHUTE, *Shedd Aquarium, Chicago, Illinois.*

SHRINKAGE OF TROUT AT DEATH AND ON PRESERVATION.—In studies on the growth of trout based on dead or preserved specimens, it is often desirable to know the length of the fish when it was alive. To compute this live length, a correction factor must be applied to the measurements taken from the dead or preserved material, to compensate for the shrinkage occurring during rigor mortis, or during preservation. To determine the value of the correction factors, some trout were measured alive, and again after rigor mortis had set in. Others were measured alive, again after they had been in approximately 10% formalin (4% formaldehyde solution) for varying periods of time, and once again after varying periods of preservation in approximately 70% alcohol. The procedure in preserving specimens was as follows: the specimens were killed and hardened in formalin solution, which was later poured off; they were then merely rinsed in water and kept in the alcohol solution without further changes until the third measurements were taken. This procedure is more or less similar to that customarily employed in preserving fish specimens.

SHRINKAGE DUE TO RIGOR MORTIS.—156 brook trout (*Salvelinus fontinalis*) varying in total length from 2.75 inches to 10.125 inches were seined on October 30, 1935, from the North branch of the Au Sable River, Crawford County, Michigan, measured alive, and allowed to die. After being kept three hours in a cardboard box in a room having a temperature of 66° F. they were measured again. The average total length of the live fish was 5.38 inches, and of the fish in rigor mortis, 5.24 inches. These figures indicate an average shrinkage of 0.14 inches in length, or 2.6%, and call for the use of a correction factor of 1.027 in order to compute the live length when the rigor-mortis length

[1] Fishes of the Hawaiian Islands, Bull. U. S. Bur. Fish., 23 (1), 1905: 267.
[2] Fowler and Bean, Bull. U. S. Nat. Mus., 100 (7), 1928: 14.
[3] Chute, Guide to the John G. Shedd Aquarium, 2nd ed., 1935: 138.
[4] Innes, Exotic Aquarium Fishes, 1st ed., 1935: 410.

alone is known. The considerable shrinkage of trout during rigor mortis has an obvious bearing on legislation and law enforcement.

SHRINKAGE FOLLOWING PRESERVATION.—84 brook trout (*Salvelinus fontinalis*) and 7 brown trout (*Salmo trutta*) were each measured 3 different times to determine the shrinkage caused by preservation. From these measurements the correction factors were computed. The results of these studies are shown below:

First and second experiments, using 38 brook trout and 7 brown trout taken June, 13, 1935:

Species	Brook Trout	Brown Trout
Average total length when alive, in inches	6.73″	6.59″
After 109 days in 10% formalin	6.37″	6.25″
Average shrinkage in formalin	0.36″	0.34″
Correction factor to determine live length from formalin specimens	1.057	1.054
After 117 additional days in 70% alcohol	6.38″	6.21″
Average shrinkage in alcohol	—0.01″	0.04″
Correction factor to determine length in formalin from length in alcohol	0.998	1.006
Total shrinkage after 226 days of preservation in formalin and alcohol	0.35″	0.38″
Correction factor to determine live length from alcohol specimens	1.055	1.061

Third experiment, using 46 brook trout taken November 9, 1935:

Average total length when alive, in inches	7.56″
After 22 days in 10% formalin	7.23″
Average shrinkage in formalin	0.33″
Correction factor to determine live length from formalin specimens	1.046
After 65 additional days in 70% alcohol	7.18″
Average shrinkage in alcohol	0.05″
Correction factor to determine length in formalin from length in alcohol	1.007
Total shrinkage after 77 days of preservation in formalin and alcohol	0.38″
Correction factor to determine live length from alcohol specimens	1.053
Correction factor to determine live length from alcohol specimens, as computed from all 3 experiments (weighted average)	1.054

The correction factor, 1.054, is greater than usually given by the few workers who have heretofore computed such a correction; for instance Van Oosten,[1] who found a correction factor of 1.016 to hold for the lake herring, *Leucichthys artedi* (Le Sueur). This circumstance is probably due to the fact Van Oosten and others determined the shrinkage of dead specimens on preservation, and thus did not consider the shrinkage due to rigor mortis.—DAVID S. SHETTER, *Institute for Fisheries Research, University of Michigan, Ann Arbor, Michigan.*

[1] Bull. U. S. Bur. Fish., 44, 1928 (1929): 273.

Herpetological Notes

ON THE BIRTH OF *CONSTRICTOR CONSTRICTOR IMPERATOR* IN CAPTIVITY.—In May, 1934, a pair of Central American boas (*Constrictor constrictor imperator*) and a pair of boa constrictors (*Constrictor constrictor*) were purchased from a dealer in the southwest. All of the snakes, except a female Central American boa, died within a month as a result of a mite infection. This female was sprayed with a Metaphen-olive oil preparation (1:10) and saved from the usual fate of mite-infected ophidians in captivity.

On July 19, 1934, this boa gave birth to two young, and in addition deposited thirteen brown leathery eggs (length 6 cm. x circum. 9.5 cm.) on the sand floor of the cage. Boa constrictors are ovoviviparous and the eggs are normally retained in the body until the embryos are ready for birth. It seems probable that in this case they were expelled prematurely, perhaps as a result of the altered environment. Two of the thirteen eggs contained well developed and living embryos which were removed from the leathery egg membranes. The snakes removed were similar in external appearance to the young which were born in a normal manner. All four offspring closely resembled the mother in color pattern, but exhibited less brilliant coloration. At birth the young averaged 36 cm. in length and 4.75 cm. in circumference. The measurements for each individual are tabulated below. The circumference measurements were taken midway between the anus and the tip of the snout. A and B are the individuals that were removed from the eggs, and it will be seen that these are slightly smaller than those whose birth was normal. The adult female was 120 cm. in length and 15.5 cm. in circumference at the time the young were born.

The young boas shed their skins within ten minutes after birth. It was necessary to aid ecdysis in those removed from the egg both by mechanical manipulation and spraying with warm water. Repeated attempts were made to induce the young snakes to feed. They drank large amounts of water but refused food until three weeks of age. At this time they shed their skins and soon afterward each seized a half-grown mouse, killed it by constriction, and swallowed it with little difficulty. After the snakes began feeding each accepted a mouse almost every week over a period of a year.

The average length of the four individuals at the end of a year was 71 cm. with a circumference of 7 cm. Measurements of the young snakes are recorded in centimeters in the table at three different dates from the time of birth to one year of age.

	A		B		C		D	
Date	Length	Circum.	Length	Circum.	Length	Circum.	Length	Circum.
7/34 (Birth)	35.5 cm.	4.5 cm.	35.0 cm.	4.5 cm.	37.0 cm.	5.5 cm.	36.5 cm.	5.0 cm.
10/34	51.0 cm.	5.5 cm.	50.5 cm.	5.5 cm.	52.5 cm.	5.5 cm.	51.0 cm.	6.0 cm.
7/35	69.5 cm.	6.5 cm.	71.0 cm.	7.0 cm.	72.5 cm.	7.5 cm.	71.5 cm.	7.0 cm.

The growth was greatest during the first three months but was not retarded during the winter because the reptiles fed regularly and were kept at a high temperature (ca. 25 C.) during the entire year. Little difficulty was experienced in keeping the young snakes healthy and vigorous, but the adult female died shortly after the birth of the young.—EARL E. HOOVER, *294 Pleasant St., Concord, New Hampshire.*

RECORDS OF *STORERIA OCCIPITO-MACULATA* FROM NORTH DAKOTA.—A specimen of the red-bellied snake, taken at Towner, North Dakota, September 11, 1934, by Karl Weber, has been deposited in the Museum of Comparative Zoology, Harvard University, by the writer. It was found in woods along the Mouse (Souris) River. This region has an average annual rainfall of 17 inches, and is transitional between the short grass and the long grass prairie.

There is one other record of this snake in North Dakota known to me, that of a specimen taken at Harlow (near Leeds) about July 17, 1932, by H. L. Conway, which was presented to the University of North Dakota.—NEAL A. WEBER, *Biological Institute, Harvard University, Cambridge, Massachusetts.*

THREE SALIENTIA OF GEOGRAPHIC INTEREST FROM SOUTHERN MARYLAND.—During the first two weeks of June, 1934, we had the opportunity of collecting a series of Amphibia in southern Maryland. Three of the species secured are of sufficient geographic interest to deserve comment:

Gastrophryne carolinensis (Holbrook).—Apparently this species has not been recorded from the state. We heard several calling from thick grass in a cat-tail swamp a few hundred feet from Cove Point lighthouse. The water was slightly brackish but *Hyla cinerea* and *H. versicolor* were present. Several other *Gastrophryne* were collected in a fresh water swamp between Cove Point and Solomon's Island. These were also calling from thick tussocks of grass with usually the rear part of the body submerged. The call seemed to us to resemble that of *Bufo fowleri* but was more explosive, shorter and higher pitched.

Hyla cinerea cinerea (Schneider).—The green tree frog was abundant in the vicinity of Cove Point and Solomon's Island. The largest chorus came from sandy flats near the bay where the water was in all probability brackish. Small groups were calling from rain water pools at some distance from the bay. The call is very similar to that of *Hyla andersonii* but more rasping or burred. There is some variation in the call. One frog having a higher pitched voice was found to be smaller than others calling in the vicinity.

Our series of 32 collected specimens as well as all those observed in the field are typical *Hyla cinerea cinerea*. Some lack the light stripe along the sides of the body and have only a tinge of white on the posterior part of the upper jaw. In others this stripe is continued beyond the tympanum and fades out on the sides of the body. A similar variation is found in a series of *H. c. cinerea* from Wilmington, N. C., in the collections of the American Museum.

The series of *evittata* in the American Museum differ from these *cinerea* in having a more vertical, less sloping profile to the snout. The former race is also said to differ from *cinerea* in its broader head but our series of *cinerea* exhibits a great variation in width and no constant difference can be found here.

It thus appears that typical *cinerea* has a more northern range than Wright and Wright (1933) have assumed. It follows that *evittata* has a more restricted range, for we found only *cinerea* in the Cove Point-Solomon's Island area. It would be interesting to know if all green tree frogs found north of the Washington area are not referable to *cinerea*.

Miller (1899) noted that the lateral stripe may be reduced in some specimens of *cinerea*, but he considered this a rare variation. In our Maryland series it is not rare. Hence it seems probable that the tendency to lose the stripe is accentuated in northern material. This is obviously a step in the direction of *evittata*. Still it is head shape and not body stripe, which distinguishes *evittata* from the typical form.

Hyla versicolor versicolor (LeConte).—In the slightly brackish swamps near Cove Point we heard a frog voice which was new to us. It resembled the familiar trill of *H. versicolor* but was more rapid, more metallic, and decidedly less resonant. That is, each note of the common tree frog seems to be composed of two notes in different keys, while this trill was pitched in one key and suggested the call of *Bufo americanus*. There were approximately 50 frogs giving this call at Cove Point on June 10. The next day there were 5 or 6 calling from rain water pools in open grassy meadows and about 15 from a densely overgrown border of a freshwater stream where *Acris gryllus gryllus*, *Rana catesbeiana* and *R. clamitans* were seen. Others were calling from a slightly brackish pool at Drum Point. We collected a series of the calling frogs and found them indistinguishable from *H. versicolor* except for an apparently smaller size.

On driving back to Baltimore we heard hundreds of these frogs calling and always with the same voice until we reached Millersville. At Warehouse Pond there were many frogs giving the typical *H. versicolor* call and others the trill we have been describing. We collected a series of frogs, waiting in each case until the frog called. The "northern" and the "southern forms" were placed in separate containers for comparison later. Driving north from Millersville only typical *versicolor* calls were heard. Hence this town seemed to be the exact point of overlap of the ranges of the two "forms."

When the series of 9 males of the "northern" and 7 of the "southern form" from

Millersville were compared no constant structural difference could be found. Nor could we find any consistent differences between the series of 34 adults from the Cove Point-Solomon's Island area and the large series of *H. versicolor* in the American Museum from various parts of the United States. There was no doubt in our mind that all gray tree frogs heard south of Millersville were the rapid trillers while all those heard north of this point had slower, more resonant calls. Further, there was an overlapping of the two types in the manner of geographical races at Millersville. It is of course possible that other differences may be found later, in the tadpole or life history, for example, but for the present it would be rash to found a race on voice alone. Nevertheless, it is interesting that there should be a constant difference in voice in this south Maryland form before any structural divergences have become fixed.

It is well known that *H. versicolor* has another call which has been called by Overton the "Turkey Root." Noble and Noble (1923) who saw this call given frequently, attributed it to failure of the male to inflate his vocal sack adequately. In the present case we have been comparing males which were calling with fully inflated sacks and without obstruction. Further, while some of the "southern" males were smaller than the "northern" this was not true of all of them. Hence the variation in voice may not be attributed to size as may prove to be true of *H. cinerea*.

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G. K. Noble and W. G. Hassler, *American Museum of Natural History, New York City.*

FOOD HABITS OF SKULL VALLEY LIZARDS.[1]—Skull Valley is situated to the southwest of the Great Salt Lake, Tooele County, Utah. The valley ranges from approximately 10 to 15 miles in width and is about 40 miles long. From north to south, located along the east slope, are "The Delle," Iosepa, Willow Spring, with Orr's Ranch near the south end. Delle is located near the northwest end of the valley with Timpie at the northeast. The principal plant associations are sagebrush, shadscale, greasewood, rabbitbrush, and juniper, which is principally a salt desert shrub formation, merging along the slopes and canyons into the northern desert shrub formation. This valley is a breeding ground of the beet leafhopper, *Eutettix tenellus* (Baker), the principal hosts of which are Russian thistle (*Salsola pestifer*) and blistercress (*Cheirinia repanda*), which grow abundantly upon the alluvial fans and on many of the slopes along the east side of the valley.

1. *Crotaphytus collaris baileyi* (Stejneger).—During the season of 1933, 14 specimens of the western collared lizard were collected in the foothills between Timpie and Iosepa. The recognizable stomach contents of these specimens consisted of 34 adult and 26 nymphal grasshoppers; 2 beetles; 1 lepidopterous larva; and 1 pebble.

2. *Crotaphytus wislizenii* (Baird and Girard).—The stomach contents of 58 leopard lizards consisted of 95 adult and 17 nymphal Orthoptera, all of which were grasshoppers; 3 cicadas, *Okanagana bella*; 4 beetles; 5 flies, 4 of which were robber flies; 8 Lepidoptera; 19 Hymenoptera, including 12 ants and 4 sphecoid wasps; 3 spiders; 9 small lizards, including 4 *Uta s. stansburiana*, 2 *Cnemidophorus t. tessellatus* and 3 *Sceloporus g. graciosus*; 2 parasitic roundworms; sand and small pebbles.

3. *Uta stansburiana stansburiana* (Baird and Girard).—An examination was made of 2,289 stomachs of the brown-shouldered *Uta*. In Table 1 the stomach contents are summarized according to the host plants among which the specimens were taken. The most conspicuous difference brought out is that lizards collected among host plants of the beet leafhopper, such as Russian thistle, blistercress, and redscale (*Atriplex rosea*) ingested large numbers of homopterus specimens; in this case 1,762 adult and 6,062 nymphs of the beet leafhopper, *Eutettix tenellus*, 47 *Agallia sanguinolenta*, together with 197 adult and 90 nymphal leafhoppers of other kinds, 1,157 aphids, 4 psyllids, 3 fulgorids,

[1] Contribution from Department of Entomology, Utah Agricultural Experiment Station. Publication authorized by Director, June 12, 1934.

1 cercopid, and 20 coccids; the total stomach contents of the 2,289 stomachs was: leafhoppers, 8,120, aphids 1,224, and fulgorids 9; all Orthoptera consisted of grasshoppers, with the exception of 5 mantids and 7 crickets; Hemiptera included 335 adult and 29 nymphal false chinch bugs, 20 pentatomids, 32 mirids including 25 tarnished plant bugs, 7 nabids, 298 adult and 94 nymphal big-eyed bugs, *Geocoris decoratus*; the beetles included 30 chrysomelids, 34 scarabaeids, 3 darkling beetles, 83 ground beetles, 7 ladybird beetles, 4 staphylinids, 13 sylphids, 2 dermestids, 1 click beetle, and 1 blister beetle; dipterous contents included specimens of at least 15 families, including 8 tachinids, 9 chironomids, 9 mosquitoes, 7 calliphorids, 103 *Chloropisca glabra*, 15 sarcophagids, 2 craneflies, 7 muscids, 11 syrphids, 5 big-eyed flies, 1 horsefly, 6 robber flies, and 1 blackfly; Hymenoptera consisted of 1,073 ants, 53 chalcids, 9 andrenids and 12 other bees, 5 vespoid wasps, 9 ichneumon wasps, 2 braconids, 5 cuckoo wasps, 1 dryinid, 1 sawfly, and 2 bembicids.

TABLE 1. INSECT FOOD OF *Uta stansburiana stansburiana*

Insect Orders	Total stomach contents of 1869 specimens taken among Russian thistle, blister-cress, and redscale			Total stomach contents of 420 specimens collected among sagebrush, rabbitbrush, and shadscale			Totals
	Adults		Immature	Adults		Immature	
Thysanura		0			1		1
Collembola		311			115		426
Orthoptera	112		226	163		154	655
Isoptera	156		0	87		0	243
Neuroptera	11		51	4		2	68
Ephemerida	1		0	0		0	1
Odonata	9		0	0		0	9
Thysanoptera	69		8	0		0	77
Hemiptera	930		506	92		23	1,551
Homoptera	3,221		6,155	106		3	9,485
Coleoptera	409		68	95		8	580
Lepidoptera	220		229	20		76	545
Diptera	615		402	24		35	1,076
Hymenoptera	1,423		0	497		0	1,920
Total Insects	7,176	313	7,645	1,088	116	301	16,637
Other Contents							
Spiders		388			34		422
Mites		155			10		165
Ticks		11			1		12
Scorpions		2			0		2
Sow Bugs		1			0		1
Round Worms		8			8		16
Miscellaneous	Insect fragments, plant fragments, sand, small pebbles, insect eggs						618

4. *Sceloporus graciosus graciosus* (Baird and Girard).—Sagebrush swifts were frequently taken in bushes as well as upon the ground. An examination of 165 stomachs showed a total content of 46 adult and 29 nymphal Orthoptera, of which 71 were grasshoppers and 3 camel crickets; 25 termites; Neuroptera included 2 adult lace wings and one aphis lion; 9 adult and 8 larval Diptera; 113 adult and 5 larval beetles, including 5 ground beetles, 13 ladybirds, 59 chrysomelids, and 4 scarabaeids; 44 adult and 5 nymphal Homoptera included 15 beet leafhoppers, 9 other leafhoppers, and 19 aphids; 29 adult and 10 nymphal Hemiptera included 12 big-eyed bugs, 8 tarnished plant bugs, and 15 pentatomids; 6 moths, 38 lepidopterus caterpillars and 1 pupa; 317 Hymenoptera included 291 ants, 1 bee, and 2 vesipoid wasps; 12 spiders; 1 scorpion; and 15 parasitic roundworms.

5. *Sceloporus occidentalis biseriatus* (Hallowell).—Two specimens of the western blue-bellied lizard had eaten 2 grasshoppers, *Melanoplus mexicanus*; 1 beetle; and 1 caterpillar.

6. *Phrynosoma douglassi ornatissimum* (Girard).—Examination of 11 stomachs of Girard's short-horned horned toad yielded 2 grasshoppers, *Hesperotettix viridis*; 2 Homoptera; 1 ground beetle; 1 moth; 176 Hymenoptera, all but 4 of which were ants; and 28 parasitic roundworms.

7. *Phrynosoma platyrhinos* Girard.—Six specimens of the desert horned toad contained 3 grasshopper nymphs; 3 beetles; 5 lepidopterous caterpillars; 130 ants; and 57 parasitic roundworms.

8. *Cnemidophorus tessellatus tessellatus* (Say).—Most of the 68 desert whiptail lizards were collected in the southeast end of Skull Valley, although specimens were taken along the eastern foothill from Timpie to Orr's Ranch. The food consisted of 34 adult and 48 nymphal Orthoptera, all except 6 crickets and 3 camel crickets grasshoppers; 24 termites; 15 neuropterous larvae, 2 being aphis lions; 5 Homoptera, 3 being leafhoppers and one a cicada; 4 hemipterous adults and 5 nymphs, all but two of which were false chinch bugs; 28 adult beetles and 22 larvae, 11 of the latter being wireworms, 5 adults being longhorn beetles, and 11 ground beetles; 3 adult, 8 pupae, and 3 larval Diptera; 9 adult Lepidoptera, 161 caterpillars, and 11 pupae; 15 Hymenoptera, 13 being ants; 16 spiders; and 3 scorpions.

An examination of these data indicates that the eight species of Skull Valley lizards included in this study are all highly insectivorous and beneficial. The parasitic and predacious insects taken were in the minority, as compared with the great number of injurious specimens ingested. Most of the insectivorous lizards are voracious feeders, and the injurious insects consumed each year by each individual lizard would undoubtedly exceed its weight many times.—GEORGE F. KNOWLTON and W. L. THOMAS, *Department of Entomology, Utah Agricultural Experiment Station, Logan, Utah.*

THE CARE OF THE BUSHMASTER AND OF CERTAIN LIZARDS IN THE NEW YORK ZOOLOGICAL PARK.—In September, 1934, a six-foot specimen of the bushmaster, *Lachesis muta*, was brought from the island of Trinidad and was placed on exhibition in the New York Zoological Park. Twenty years had passed since the last one had come to the reptile house and only three other specimens have been exhibited at the park during the past thirty-five years.

Adult bushmasters have seldom, if ever, been known to take food voluntarily in captivity and this specimen was no exception, so it was decided to force feed the snake once a week in an attempt to keep it alive and accustomed to confinement. Since the specimen was only about half grown, the process of pinning down its head, grasping it securely just behind the head with a firm grip that included the neck, and forcing a freshly killed rat into its mouth was not difficult. This was done by Dr. Raymond L. Ditmars, the Curator of Reptiles. Fortunately, the snake was not alarmed by the procedure and assisted the process by swallowing the rat without further urging.

Soon after the arrival of the serpent, it was noticed that it was having difficulty with its old skin, so cage humidity and temperature were carefully regulated to approach the tropical forest conditions under which it normally lived. Once and sometimes twice a day the bushmaster received a shower of tepid water from a hose fitted with a sprinkler nozzle. The cage was so saturated with excessive humidity that the snake successfully shed its skin on two occasions.

At first the snake had some trouble in getting the skin started over its head. The following technic was employed with marked results. Contact was made with the head by use of a wad of steel wool, approximately the size of a golf ball and flattened at the top, attached to the end of a five-foot stick. As the shredded metal touched the skin, the reptile "nosed" about until the skin caught onto the wool. By careful manipulation of the stick, the skin was loosened and directed over the head. Once the ecdysis was started, the process of shedding went on to completion in the usual manner. The steel wool was also employed for the removal of a few body patches of skin.

Two months later, in spite of the fact that after a regular diet of force-fed rats and young rabbits and two successfully shed skins the condition of the snake was apparently improved, it was found dead one morning. Autopsy revealed that the bushmaster was heavily infested with several types of parasites, so many and so well developed that it had probably carried them back from Trinidad.

Lizards have also presented problems in regard to their upkeep at the New York Zoological Park. Many interesting types have never been successfully exhibited at the park due to their refusal to take water, which is so necessary to their existence. Adequate water available in their enclosures still resulted in dehydrated reptiles. Drinking dishes sunk flush with the ground were overlooked and many forms would stumble upon the water and turn aside without partaking. Certain species, however, would sit in the liquid and apparently take in moisture through their skin. *Varanus*, *Ameiva*,

Cnemidophorus, and others thrived in this manner, but not so with the anoles, horned and collared lizards, etc. (*Varanus* also drinks freely, but some forms spend a great deal of time in the water.) The latter types will lap water from the vegetation when it is sprinkled upon the leaves and we have found that the drops shaken from a whisk broom will attract lizards to leaves. This sprinkling also works with noticeable success for such arboreal snakes as *Boa*, *Leptophis*, and *Oxybelis*, that drink ordinarily from rain and dew that has collected in the leaves. For some of the delicate types, other methods are used. The large Cuban anole, *Anolis equestris*, and *Gerrhonotus* have been induced to drink as follows. The lizard is held gently but firmly in one hand. The lizard's nose is lightly tapped so as to induce it to open its mouth; this accomplished, water is poured down the throat from a teaspoon. Generally the lizard swallows the liquid without hesitation. Care must be taken not to touch the jaws when employing the spoon, as the animal is apt to bite and in doing so will break its teeth and injure itself when the jaws clamp down on the metal spoon. This treatment has been kept up every day. Other devices instead of a spoon may be employed, such as a syringe with a rubber tube, which does away with any possibility of the reptile injuring its mouth. It is Dr. Ditmars' opinion that one cannot give the reptiles too much water and by insuring the necessary liquid nourishment he has been able to successfully keep the Cuban anole and many other lizards over relatively long periods of time.—ARTHUR M. GREENHALL, *251 W. 89th St., New York City*.

OBSERVATIONS ON *SCAPHIOPUS HOLBROOKII* (HARLAN).—During the last two years the writer has had an opportunity to watch the breeding habits and early development of the spade-foot toad, *Scaphiopus holbrookii* (Harlan). Since some of his observations are not in agreement with published accounts and others cover peculiarities apparently not on record, it has seemed advisable to describe them.

The animals were found in temporary rain ponds in the bottom-lands of the Connecticut River near Northampton, Massachusetts, in probably the same station as that in which E. R. Dunn found them in 1928 (Bull. Boston Soc. Nat. Hist., 57). The soil is clay, of the type described in the geological reports as silt loam. Several of the previous accounts have reported the spade-foot in sandy areas. Although there are plenty of sandy areas with similar temporary rain ponds within easy reach of the present location, careful and prolonged search has failed to show any indication of spade-foot habitation of these areas.

In both 1933 and 1934 the appearance of the toads coincided with the spring flood stage of the Connecticut River. In 1933 they appeared for only one night, April 18, following two days of very heavy rainfall. In 1934 they appeared first in fair weather, April 17, although rains several days before had filled their ponds. A thunderstorm and heavy rains brought them out again on the night of April 24, but all had vanished by morning. The area was visited every night and on May 3 and 4 they made their third appearance of the year, also during heavy rains. On each occasion eggs were deposited, and never were any of the toads visible during daylight hours.

The call of the spade-foot toad has been described as ear-splitting groans, deafening agonizing roars, as resembling the sound of a steam whistle, and as like a steam caliope. It was with great interest, therefore, that on their third appearance in 1934 we found *Bufo americanus* in full chorus with them. As for the carrying power of the calls, the cry of the spade-foot carried not more than a few yards farther than that of the common toad. We hesitate to add any more similes but since most descriptions of the call do not seem to fit we might say that to us it resembles the last notes from a toy squawking balloon, when close by, or the distant honking of geese when one is at some distance from the ponds. We have found only one reference to a spade-foot singing while underground (A. H. Wright, 1932). We found this to be one of the most striking peculiarities of the animal. In the early part of the evening, between nine and ten o'clock, no toads were visible in the ponds, but from all around the margin came their much muffled calls. It was a most peculiar sensation to be in the midst of the chorus but to have only a barren expanse of sticky clay visible under the flashlight. Excavating with considerable difficulty we found the songsters to be several inches below the surface in apparently quite solidly packed earth. No sign of entrance to the burrows was visible. As the eve-

ning wore on one after another pushed out to the surface and entered the pond to float and sing with greater vigor. The chorus reached its height shortly after midnight.

On the occasion in which both *Scaphiopus* and *Bufo* were in the same pond it was of interest to note decided habitat preferences. The pond extended partly over pasture and partly over recently ploughed corn field. The spade-foots kept over the latter and the toads over the grassy part. A few spade-foots taken to the grassy end and released soon made their way back to the muddy-floored end. Their eggs were draped around submerged corn stalk stubs and none were found in the grassy part of the pond. There was no appreciable difference in the depth or temperature of the two ends of the pond.

In regard to transformation, the reputed rapidity has not revealed itself. In 1933 the pond dried up in three weeks, at which time no signs of hind legs were visible on the tadpoles. Some tadpoles were kept in ordinary balanced aquaria but were lost through failure to provide a soft mud bottom for them, their thin ventral sides apparently being unable to stand the friction of the sand. In 1934 the eggs hatched in two days at a water temperature between 50 and 60° F. A large tank was set up outdoors with conditions approximating those of the ponds as closely as possible, and some eggs from the April 24 appearance put into it as checks. In the ponds large quantities of drowned earthworms formed the chief food supply of the tadpoles. The tadpoles in the tank were also fed on earthworms, supplemented by scraps of meat. On the thirty-first day the last of the ponds dried completely, leaving hundreds of dead tadpoles on top of the dried mud. There was no indication that the disappearance of the water speeded up metamorphosis in the least, and no indication that the spade-foot tadpoles attempted to burrow into the mud to escape drying. The temperature during this time had varied little from normal for this locality. The air maxima ranged from 64 to 90° F., with an average of 73, and the minima from 33 to 61, with an average of 46°. Since the development of the captive tadpoles had paralleled almost exactly that of those in the ponds so far, it seems safe to assume that, had the ponds not dried, it would have continued to do so. The captives developed hind legs between the thirty-fifth and the thirty-eighth day after the eggs were laid. The characteristic dorsal stripes began to appear soon afterwards, and the tadpoles acquired their front legs and left the tank between June 10 and June 25, or from forty-eight to sixty-three days after the eggs were laid. Spade-foot tadpoles have been reported to transform in less than two weeks, and several accounts list the time at about thirty days, but do not give the temperatures. It is conceivable that during the midsummer months the development may be very rapid, but our observations indicate that the usual spring spawning develops but little faster than that of the American toad. Possibly some observers have been misled into thinking that only one spawning occurred, when actually the spade-foots may make several emergences during one season. Their habits of digging in for the daylight hours and of tuning up late in the evening makes it easily possible to overlook some of their one night appearances.

A few adults were kept in captivity for a while in an effort to learn something of their habits. They became active each night, but did not feed readily and therefore were soon liberated. They showed no interest at all in earthworms, and no eagerness for anything except soft green grasshoppers and katydids, which we were unfortunately unable to obtain in any quantity. This lack of interest in most small insects was in marked contrast to the behavior of the recently transformed young, who attempted to eat any small moving object that attracted their attention, and thrived on *Drosophila*, feeding freely in the daytime and showing little or no inclination to burrow. The adults had no fixed retreats but made a new excavation each time they retired. In burrowing they twisted rapidly in corkscrew fashion and so descended much more vertically than does the common toad. The earth fell in upon them as they dug, so that no trace of the burrowing remained. When put in tanks of various depths the spade-foots retreated at once from the light and almost always dug to the bottom of the tank, even to depths of two feet. When the tanks were kept in a dark cellar the toads came up and usually remained at the surface or only partially submerged. A favorite attitude was one in which the top of the animal's head was level with the surface, with one or both eyes showing. It seems probable that in the wild state this attitude may be characteristic.

It affords the animal almost perfect concealment and at the same time leaves it in readiness to leap out at any passing insect.

The site of the ponds is used as a truck farm as soon as it dries in the spring, so that search for the adults during the summer is impracticable. Apparently the only opportunity for the development of a new generation of spade-foots occurs when more than average rainfall comes in late spring and early summer.—ERNEST C. DRIVER, *Smith College, Northampton, Massachusetts.*

SCAPHIOPUS HOLBROOKII IN KENTUCKY.—After nearly forty-eight hours of intermittent but rather heavy showers, frogs and toads of several species were heard calling on the night of June 3, 1935. A strange note for this part of the country was traced to a small pond about one hundred fifty feet long and one hundred feet wide, whose water was very muddy. In some places it exceeded two feet in depth. At 10:00 P.M. the temperature of the air was about 68° F.

The pond is in a low spot among cultivated fields with considerable brushy ground too rough to cultivate scattered near by. The pond is there only in wet weather, but willows and marsh grasses indicate that the area is usually damp if water does not actually remain above ground.

After some search, a specimen of *Scaphiopus holbrookii* (68 mm. long) was observed giving the usual call in a clump of grass well out in the pond. It was captured and preserved. Lack of time prevented the taking of more specimens. Judging by the calls, there must have been about a dozen male spadefoots in the pond. The extreme muddiness of the water made a search for eggs useless.

The next few nights no spadefoot calls were heard, although *Acris gryllus*, *Hyla versicolor*, and *Bufo fowleri* were singing in numbers. On the night of June 3 one pair of *Bufo fowleri* were observed clasping.

The pond in which the *Scaphiopus* was taken is about two and one-fourth miles north of the town of Horse Cave in Hart County, Kentucky. It is just off the Dixie Highway (U.S. 31W) south of a small lane that leaves the highway almost opposite the entrance to Mammoth Onyx Cave.

The preserved specimen is now in the display collection of amphibians at the Mammoth Onyx Cave. The writer has been unable to find any previous record of this species in Kentucky.—LEONARD GIOVANNOLI, *Mammoth Onyx Cave, Horse Cave, Kentucky.*

OVIPOSITION AND EMBRYOS OF SOME WESTERN LIZARDS.—Courting activity of *Sceloporus o. occidentalis* (Baird and Girard) was noted in the laboratory on March 19, 1932, and two of the females laid eggs 82 and 89 days later. Since these lizards were not watched continuously, courting may have occurred at other times. Seven other females have laid eggs in the laboratory from 11 to 51 days after collection from the field. During the laying of the eggs, the lizard holds her tail elevated at an angle of about 10 degrees, at the same time raising the anterior part of the body. The posterior part of the body is kept close to the substratum. The egg is moist and seems to be extruded by contractions of the cloacal, as well as body musculature. After the egg is about two-thirds out of the cloaca, the lizard may crawl a bit, dragging her hind legs and keeping the anal region pressed to the sand. In this way the egg is deposited. At first it appears creamy white and somewhat translucent, but soon after drying, it becomes an opaque, chalky white.

A horned toad, *Phrynosoma m'callii* (Hallowell), sent by Harry McElroy from Tucumcari, New Mexico, in July, 1933, was isolated in a battery jar. On July 18, 1933, at 8:30 A.M., the author counted twenty-two eggs on the sand. From 8:30 A.M. to 9:00 A.M., six more were laid, making a total of twenty-eight. During oviposition the lizard raised the fore part of her body high on the front legs. By arching her back, the posterior part of her body was also raised off the sand but the anal region was held pressed to the substratum. Then by snake-like movements or undulations from side to side, as well as contractions of the abdominal and adjacent musculature, the eggs were worked back into the cloaca. This was accomplished slowly with periodic spasms of effort. After the egg passed into the cloaca, the lizard raised her tail and by contractions of the musculature in the region of the cloaca, seemed attempting to force the egg out

through the anal aperture. Then she slowly pulled herself along the sand with the anus pressed to the surface, at the same time making sidewise undulations of the body, thus depositing the egg. Of the twenty-eight eggs laid, the average length and breadth were 13.0 mm. and 8.6 mm., respectively.

Of nine female *Sceloporus o. occidentalis*, the total number of eggs laid by or removed from each lizard varied from six to thirteen, averaging nine. Of thirty-eight fertile eggs laid in the laboratory by three lizards, the average size was 11.5 mm. long by 7.0 mm. wide. The germinal disc was variable in size and position, being usually toward the center on one side of the egg. It is not free to rotate as in the egg of the chick. Of the thirty-eight eggs above measured, the germinal disc averaged about 8.2 mm. long by 6.9 mm. wide, the length and breadth corresponding to that of the egg. Generally, the eggs are all laid within a period of a few hours. One female, however, deposited one egg on May 1, two on May 2, three on May 3, and one each on the following days, May 4, 5, and 8.

Of three female *Sceloporus o. biseriatus* (Hallowell), the total number of eggs laid by or removed from each lizard was seven, eight and eleven, all fertile.

A number of eggs from the three species of lizards, *Sceloporus o. occidentalis, S. o. biseriatus*, and *Phrynosoma m'callii*, have been opened and the embryos removed, fixed, and stained for whole mounts by the ordinary embryological methods. The embryos at the time of oviposition correspond structurally but not in size to about a three-day-old chick embryo (approximately thirty-seven somites). The author believes that some of the embryos are probably older than normal because of retention of the eggs in the body of the female due to laboratory conditions. In some cages at one end, rotting wood and sand were kept wet with water. The lizards always deposited the eggs in the wet sand and sometimes buried them. Some lizards died during or before oviposition and the eggs were then removed. In a few cases the eggs removed were larger, but mostly were of the same size as those laid. The living embryos, supposedly normal, measure about 3 to 5 mm. through their longest axis which is from the region of the mid-brain to the outside curvature of the tail region.—SHERWIN F. WOOD, *Los Angeles Junior College, Los Angeles, California.*

A PREOCCUPIED GENERIC NAME OF A SOUTH AFRICAN OPHIDIAN.—Through the kindness of Mr. Curtis W. Sabrosky, recently of Kansas State College at Manhattan, Kansas, my attention has been called to the fact that the genus *Sepedon* proposed in 1820 by Merrem (Tent. Syst. Amph.: 146) for a species (*haemachates*) of South African snakes is preoccupied by *Sepedon* of Latreille (Histoire Naturelle, generale et particuliere des Crustaces et des Insectes, 14, 1804: 305), a genus of Diptera of the family Tetanoceridae (Sciomyzidae). I propose the generic name ***Sepedonophis*** to replace Merrem's preoccupied name.—HOBART M. SMITH, *Department of Zoology, University of Kansas, Lawrence, Kansas.*

COLORADO RECORDS.—A specimen of the Texas horned lizard, *Phrynosoma cornutum* (Harlan), was collected at Boulder, Colorado, on August 27, 1935, by Dale Denham. It has been recorded once before from Boulder (Ellis and Henderson, Amphibia and Reptilia of Colorado, Univ. of Colo. Studies, 10 (3), 74, 1913) but the record was complicated by the fact that a specimen had escaped from captivity just previously in the same neighborhood. Four uncertain Denver specimens (*loc. cit.*) do not serve to clarify the situation, and it is possible that the present record is an escape.

The western garter snake, *Thamnophis ordinoides vagrans* (Baird and Girard), was found to be fairly common during the summer of 1935 in the region of Science Lodge, the University of Colorado's biological and geological station in western Boulder County, at altitudes ranging between 9,000 and 10,000 feet. The highest altitude at which it was observed was at Hill's Mill, a short distance northwest of Science Lodge, at approximately 10,500 feet.

The Texas black-headed snake, *Tantilla nigriceps* Kennicott, was found at Boulder, July 18, 1935, at Red Rocks, just west of the city limits, by Weston Reynolds. It has been reported here only once before (*loc. cit.*) in December, 1914, when it was found in a trench being dug for a pipe line.—HUGO G. RODECK, *University of Colorado Museum, Boulder, Colorado.*

NOTES ON THE AMPHIBIANS OF THE PORTLAND, OREGON, AREA.—The amphibians occurring in the vicinity of Portland, Oregon, have had very little attention from naturalists in the past and these notes have been written with the primary purpose of listing the species known to inhabit this region.

For the past few years, the writer has collected a number of specimens and through the generous help of Dr. Tracy I. Storer, of the University of California, the identifications have been verified.

The Portland area lies in Multnomah County, Oregon, in the Humid Transition Zone with the typical fauna and flora of such regions. Along the Willamette and Columbia rivers, black cottonwood (*Populus trichocarpa*), big-leaf maple (*Acer macrophyllum*), several species of willow, Oregon ash (*Frarinus oregona*), and alder (*Alnus oregona*) may be found. On the higher foothills, Douglas fir (*Pseudotsuga taxifolio*), western red cedar (*Thuja plicata*), hemlock (*Tsuga heterophylla*), dogwood (*Cornus nuttali*), and vine maple (*Acer circinatum*), are the most abundant trees. A dense mass of lesser vegetation covers the forest floor.

The following amphibians have so far been found in this region:

1. *Triturus torosus* (Eschscholtz).—Very abundant at Portland, living under rotten logs or bark. In the spring large numbers of them may be found in stagnant pools.

2. *Ambystoma macrodactylum* Baird.—Larvae of this salamander have been secured by the writer in a small pond on Sauvies Island, apparently the first record of the species for this region.

3. *Ambystoma tigrinum* (Green).—There is a specimen in the U. S. National Museum from Portland but I know of no other records. It is possible that the locality or the identification may be erroneous.

4. *Ambystoma paroticum* Baird.—I have taken only one specimen of this interesting species. It was found under moist leaves at the edge of a small pond inhabited also by *Triturus torosus* and *Dicamptodon ensatus*.

5. *Dicamptodon ensatus* (Eschscholtz).—This large land salamander sometimes reaches a length of nearly twelve inches. The species is fairly abundant at Portland but more abundant in the region of Eagle Creek, Multnomah County, Oregon, where they are often caught by trout fisherman using salmon eggs or worms for bait.

6. *Plethodon vehiculus* Cooper.[1]—This beautiful little salamander may be found under moist leaves or more often under bark or logs. It is very abundant in the Douglas fir forests near Portland.

7. *Plethodon dunni* Bishop.—This species has been collected by the writer in the Portland vicinity on the west side of the Willamette River, Clackamas County. It is a more abundant species near Estacada, Clackamas County, where specimens were found in considerable numbers in a gravel slide near Eagle Creek.

8. *Ensatina eschscholtzii* (Gray).—May be found in the same places as *P. vehiculus*. It is very abundant; like most of our amphibians, its life history has not been carefully worked out.

9. *Aneides ferreus* Cope.—This salamander has not been previously recorded from Portland. I have taken it on the hills south of Portland on the west side of the Willamette River, Clackamas County, on Sauvies Island, and at Eagle Creek Park. It is not very abundant, however, and difficult to capture because of its swiftness. Specimens taken in this locality are somewhat larger than those taken in Mendocino County, California; two of my specimens measure 133 and 125 mm. respectively.

10. *Bufo boreas boreas* Baird and Girard.—This abundant toad is especially conspicuous in the spring when great numbers congregate at ponds to spawn. Many larvae have been observed by the writer along the Columbia and Willamette rivers in May and June.

11. *Hyla regilla* Baird and Girard.—This *Hyla*, one of our commonest amphibians, is found in numbers during March and April along the borders of sloughs and marshes.

12. *Rana aurora aurora* Baird and Girard.—This frog is quite abundant in the region of Portland throughout the year except in December, when all of our frogs are in hibernation. It is an inhabitant of the deep forests, resting under the cool sword ferns of this region during the day and often coming forth at night in search of food.

[1] Bishop, Sherman C., Proc. Biol. Soc. Wash., 47, 1934: 171.

13. *Rana pretiosa* Baird and Girard.—Common along the sloughs of the Willamette and Columbia rivers. It is mainly aquatic, seldom leaving water.

14. *Rana catesbeiana* Shaw.—Introduced into the Columbia River Basin and well established in most of our larger sloughs. However, unless legislative action is taken to restrict the taking of bullfrogs, the local "frog farmers" will exterminate, from the wild state, a species of great beneficial value.—STANLEY G. JEWETT, JR., *Fish and Game Department, Oregon State College, Corvallis, Oregon.*

AN OVOVIVIPAROUS *SCELOPORUS* FROM TEXAS.—Since but a few species of the genus *Sceloporus* are known to be ovoviviparous, the following life history notes on *S. disparilis* Stejneger, a form which has been relatively rare in collections, should be of interest.

In April, 1934, several young of this lizard were taken on retama and mesquite trees near Edinburg, Texas, in the Lower Rio Grande Valley. These ranged between 45 and 55 mm. in total length. No adults were taken that year.

On April 8, 1935, other young were taken and a question was raised concerning the period of egg laying. Three days later a female apparently laden with eggs was taken and placed under observation. She remained in good condition during the next two weeks, but laid no eggs. However, at 4 P.M. on April 25, it was discovered that twelve young had been born since noon, only one of which was actively running about. This young specimen measured 21 mm. in body length and 46 mm. in total length. The five more or less regularly spaced zigzag cross lines on the body and the fourteen bars on the tail, characteristic of the adults and of the other young taken previously and since, were present. The other eleven were still in their hyaline sheaths which were heavily coated with sawdust used in the cage, and the drying action of the sawdust had made cases from which the young could not emerge. Several of them were still alive when discovered, but efforts to revive them failed. The young, doubled up in their thin sheaths in oval shaped masses, measured about 14 mm. in greatest diameter.

Two other gravid females taken on April 20 were dissected at this time and in one of these eight embryos were found on the right side and six on the left. However, three of those on the right were well developed while the other five were apparently infertile eggs considerably smaller. In the other female three well developed young and two infertile eggs were found on the left side but none on the right.

All of these well developed young were inclosed in transparent sheaths with no indication of the usual leathery skin found in reptile eggs, so there is no doubt that *Sceloporus disparilis* is an ovoviviparous representative of the genus in the United States. Several other females were dissected at this time but none were found with young.

From the antics of males reported by students who observed them on mesquite trees on the Junior College campus on October 7, 1935, it was obvious that they were courting. Several males at this time were almost black, but in the collecting bag they turned to a light gray with a faint greenish cast, while later in a glass cage they took on an olive cast. In courting the males bobbed up and down on their fore legs and expanded the throat membrane in a fan shape.

A female taken at this time was dissected and found to contain six yellow embryos on the right side and five on the left. These measured approximately 3.8 mm. in diameter. The dissection of a female taken on October 22 revealed five embryos on the right side and four on the left. These averaged about 5.4 mm. in diameter.

From the above findings it is obvious that about five to six months are needed for the full development of the embryos, and that the lizard is ovoviviparous.—STANLEY MULAIK, *Edinburg, Texas.*

AN UNUSUAL HABITAT RECORD FOR *LAMPROPELTIS TRIANGULUM GENTILIS.*—In a collection of reptiles made by F. M. Carpenter there was a *Lampropeltis triangulum gentilis* (Baird and Girard) with the following data: About 200 ft. down Gilsenite Mine at Rainbow (6,110 ft.), Uinta County, Utah, collected in 1934. Mr. Carpenter informs me that several other snakes of apparently the same species have been caught in this same mine. How these snakes got into the mine and why they did so is certainly a cause for speculation.—BENJAMIN SHREVE, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

Reviews and Comments

ÜBER DEN KIEFERMECHANISMUS DER KNOCHENFISCHE. By W. H. Van Dobben. Archives Néerlandaises de Zoologie, 2 (1), 1935: 1–72, 50 figs.—Van Dobben describes in systematic order, following Kyle's classification, the jaw mechanisms of 26 species of fish, all but 2 of them from Holland, with a preliminary detailed analysis of the mechanism in *Perca fluviatilis*. The material is thus a random sample of teleosts, 6 Physostomi and 20 Physoclysti. The apparatus in each fish is considered by itself, with little comparative information; the details therefore not always adequately evaluated. The illustrations, some of which show the mouth shut and open, with diagrams of mechanical principles, are good as far as they go, but are too sketchy for comparative purposes. On the whole, however, these descriptions add substantially to our knowledge of jaw functions. There is no reference to Gregory's *Fish Skulls* (1933),[1] a work too important to overlook.

The author discusses next the bearing of the jaw mechanism and neurocranium on classification. He says that while both show, with exceptions, a definite progress through the Physostomi, the diversity among Physoclysti is so great and apparently so independent of actual relationships that we cannot hope at present to use either the jaws or the neurocranium in taxonomy. The jaws are specifically adapted in each fish to its feeding habits, and a certain mechanism appears whenever fish feed in certain ways, regardless of relationships. This opinion follows naturally from his rather uncritical study. He did not select his material with a view to finding out how far the mechanisms themselves can be classified in the first place. In the second place, he did not distinguish between the essential and the incidental features of each mechanism as a basis for comparison. He could not, then, realize that he was dealing with an aggregate-character which affords more evidence on relationships than any simpler quantitative characters can possibly give, provided it is followed far enough. It is true that mechanisms are above all adaptive and that the habits of a group of fishes determine broadly the nature of their mouths. Thus a sucking or a nibbling apparatus may appear independently in many different groups which suck or nibble. But it is not true that the intricate details of a jaw mechanism are determined directly by the manner in which a fish must get its food. Two sucking mechanisms, if derived from separate sources, are alike only superficially. Each carries within it many deep-seated features of the type of apparatus from which it came. These features, which can be discovered if enough comparative material is used, may persist through a great variety of life habits in the course of fish evolution (Eaton, 1935).[2]

Van Dobben partly redeems himself, in this reviewer's opinion, by a vigorous attack on the findings of Kyle and Ehrenbaum (1929)[3] by which they try to attribute the specific form of the jaw mechanism to pure mechanical force acting during ontogeny. But his only substitute for this is the opposite extreme, biological mysticism. He maintains in conclusion that we know nothing of evolution and that we must therefore limit ourselves to harvesting data without daring to touch our admittedly weak classification. Dismayed by the prospect he has sought other pastures and is now an ecologist.—Theodore H. Eaton, Jr., *University of California, Berkeley, California.*

A BOOK OF TROUT FLIES. By Preston J. Jennings. The Derrydale Press New York City, 1935: i–xvi, 1–190, illustr. $20.00 (850 copies).—This book represents the first serious attempt in America to correlate a part of the bewildering series of artificial

[1] Gregory, W. K. Fish skulls; a study of the evolution of natural mechanisms. *Trans. Amer. Philos. Soc.*, 23, 1933: i–vii, 75–479.
[2] Eaton, T. H., Jr. Evolution of the upper jaw mechanism in teleost fishes. *Jour. Morph.*, 58, 1935: 151–172, 15 figs.
[3] Kyle, H. M., and Ehrenbaum, E. In: Grimpe-Wagler, Die Tierwelt der Nord- und Ostsee, Leipzig, 1929.

trout flies with natural stream insects. A general discussion of the "naturals" is followed by directions for amateur collection of insects. An account of the structure and habits of each order is followed by a description of the species considered important, a list of dates when they were collected on various streams and personal observations and descriptions from scientific literature of their structure and habits. Collections of adult insects which trout were observed to feed upon, made throughout the fishing season on some of the principal trout streams of New York, New Jersey and Pennsylvania were identified for the author by specialists. Mr. Jennings measured and studied these insects and gives detailed directions for tying standard artificials most closely resembling them or suggests variations of these or new patterns. The author considers the Ephemerida most worthy of imitation by the fly fisherman. Sixty-four figures of naturals and artificials, most of them in color, make the book especially attractive. The coloring—apparently hand painting of printed outlines—is imperfect in some cases. Use of accurate scientific names for the insects described and critical reading by Dr. Spieth makes this book of permanent value. It is hoped that a popular edition may soon be forthcoming.—A. S. HAZZARD, *Institute for Fisheries Research, University of Michigan, Ann Arbor, Michigan.*

SOME RECENT FISH BOOKS.—Books on fishes continue to be ground out in considerable numbers. Several which have recently appeared are noticed below:

FISH and GAME NOW OR NEVER A CHALLENGE TO AMERICAN SPORTSMEN ON WILDLIFE RESTORATION. By Harry Bartow Hawes. D. Appleton-Century Co., New York and London, 1935: i–xvii, 1–332, 12 sketches and 21 half-tone pls. $3.00.—As indicated either by the title or the reputation of the author, this book is the product of an ardent crusader, a sincere crusader who has won a high place in the field of conservation and wildlife restoration by deeds as well as words. The tone of the book is indicated by the author's list of the "forces of destruction": 1, the domestic cat; 2, the crow; 3, the mongrel dog; 4, the lethargic public official; 5, the sportsman and fisherman who do not organize; 6, the game bootlegger; 7, the hawk; 8, the sentimentalist. Restoration is the keynote of the proposed solution for the depletion of wildlife; a vigorous 7-year campaign is urged to complete the basic set-up for this work.

THE FISHES OF NEW ENGLAND. THE SALMON FAMILY. PART 2.—THE SALMONS. By William Converse Kendall. *Mem. Boston Soc. Nat. Hist.*, 9 (1), 1935: 1–166, col. pls. 1–11. $4.00.—The land-locked salmon of Sebago Lake and some other New England waters is regarded as a distinct species, *Salmo sebago*, though no real proof is offered that its characters in form and color are inherited. Nor does the author point out that the differences between the land-locked and the sea salmon are paralleled by the differences between the land-locked rainbow trout and the sea-run steelhead, or between any land-locked salmonoid and its sea-run cognate. Though the author may not have solved this general problem of fundamental significance in systematics and speciation, nor even the special problem of the systematic status of the New England salmons, he has saved and prepared, for its ultimate solution, a large amount of data which otherwise would probably have been lost forever. That in itself is an almost priceless contribution. Despite the trimming required by economy, this memoir contains an enormous quantity of information on the natural occurrence, abundance and habits, and on the great variations (with locality, age, sex and season) in body form and color, of the salmons of New England. Eleven of the variant types are finely illustrated on large colored plates, from paintings by Walter H. Rich. Well may the Dean of American ichthyologists be proud of this magnificent monograph, the production of one of his life-long researches.

THE MARINE FISHES OF NOVA SCOTIA. By V. D. Vladykov and R. A. McKenzie. The Imperial Publishing Co., Ltd., Halifax, N. S., 1935: 1–113, 131 figs. $1.50.—This book lists and gives brief, popular descriptions of 151 species, including several recently reported in Nova Scotia for the first time by Dr. Vladykov. The mixture of northern and southern types in Nova Scotia is attributed to the great seasonal differences in water temperatures. Crude outline figures, of the type unfortunately now becoming the vogue in local fish books, are used to illustrate most of the species. The keys are of the "If, But if" type. The entire booklet, in fact, is designed for popular use.

THE MIGRATIONS OF ANIMALS FROM SEA TO LAND. By A. S. Pearse. Duke University Press, Durham, North Carolina, 1936: i–x, 1–176. $3.00.—In this present-day biological world of specialists, we should give thanks that a few synthetic minds are still producing broad monographs, to save us from a complete loss of general perspective. In our gratitude, we who are specialists should not magnify the occasional omissions or misstatement of details, in our own field, which occur in such general treatises. This, our little field, is but one of many which needs to be covered in the synthesis of such a subject as the migrations of animals from sea to land, either directly or through fresh waters, or into fresh waters only. The thoroughness of treatment and the extensive and well chosen bibliography in the contribution under review indicate a good job well done. The structural and physiological adaptations, necessitated in the difficult conquest of freshwater and terrestrial habitats by marine animals, is the main thesis of this thoughtful little book.

AN AQUARIUM BOOK FOR BOYS AND GIRLS. By Alfred Morgan. Charles Scribner's Sons, New York and London, 1936: i–xi, 1–180. $2.00.—This book, apparently a simplified version of the author's *Tropical Fishes and Home Aquaria* published by the same firm in 1935, is written in a happy style, simple but not monosyllabic, understandable because the needed technicalities are well explained as they are introduced, rather than being awkwardly and obscurely avoided as is the custom in books for the juvenile mind. The principles of aquarium culture and of aquarium fish biology are treated in a satisfactory way, considering the intent of the book. The common aquarium fishes are then dealt with in an elementary yet informative way. A chapter on "Aquarium Fishes You Can Catch Yourself" affords our native fishes more space than usual in aquarium books, and should prove valuable for school use. Unfortunately the standard of accuracy in this section, in such matters as scientific names, is below that of other chapters. About two-fifths of the book is devoted to the biology and culture of amphibians and reptiles. The numerous sketches and the few half-tone plates amply illustrate this worth-while contribution to aquarium literature.—CARL L. HUBBS, *Museum of Zoology, University of Michigan, Ann Arbor, Michigan.*

1001 QUESTIONS ANSWERED ABOUT YOUR AQUARIUM. By Ida M. Mellen and Robert J. Lanier. Dodd, Mead & Co., New York, 1935: i–xiii, 1–450, 85 figs. (3 col.). $3.00.—This book, designed as a popular aquarium reference, deserves more attention than it is likely to receive from amateurs. Unfortunately the authors insisted on living up to their very original title by writing the whole work in question and answer form (the final count being 1074 questions). As a result the sense of orderly arrangement is lost and the pages look more like those of an interlinear crib of Caesar's Gallic Wars than like those of a book for hobbyists. In spite of this criticism and others which will come inevitably from professional biologists the book is a very useful one containing a great deal of pertinent information not only on the fresh-water aquarium and its animals but also much salt-water aquarium data which is not accessible to amateurs. The book contains numerous photographs, three very decorative color plates, and several drawings, among which is the world's worst picture of a dragon fly larva. Perhaps the authors' greatest misfortune is that their book is bound to be compared with Innes' incomparable *Exotic Aquarium Fishes*.—EDWARD T. BOARDMAN, *Cranbrook Institute of Science, Bloomfield Hills, Michigan.*

EDITORIAL NOTES AND NEWS

Meetings of Society

PLANS are being laid for the 1936 meeting of the AMERICAN SOCIETY OF ICHTHYOLOGISTS AND HERPETOLOGISTS, to be held at the University of Michigan on August 31 to September 1 or 2. Attention is again called to the meeting of the AMERICAN FISHERIES SOCIETY to be held on September 2 to 4 of the same week, in Grand Rapids, Michigan. The WESTERN DIVISION of our Society will meet on June 16 to 20 at the University of Washington in Seattle, as an associated society of the Pacific Division, American Association for the Advancement of Science. Prof. Arthur Svihla, Washington State College, Pullman, is in charge of the program. A symposium on oceanography, including fisheries, will take place on June 16.

Herpetological News Notes

AN INTERNATIONAL SNAKE EXPOSITION, the first ever held, is being staged at the Grand Central Palace, New York City, May 8 to 17, under the auspices of the Staten Island Zoological Society, Carol Stryker Director, with the active support of an executive committee of eminent herpetologists. The Exposition is non-commercial, its purpose to stimulate interest in snakes and through educational methods to overcome some of the prejudices against them and to reduce their indiscriminate slaughter. Over 2000 live snakes, including such rarities as flying snakes, kraits, sea snakes and king cobras, are exhibited by institutions, private collectors and dealers from America and many foreign countries and there is a daily program of such demonstrations as venom extraction, forced feeding and the latest scientific treatment of venomous snake bites.

Proceeds will be used to purchase birds, mammals, reptiles and tropical fish for the zoo which is being constructed in Barrett Park, Staten Island, as a work relief project, by the New York City Park Department. It is hoped that the members of our Society will show their interest in the aims of this new type of educational zoo by their hearty support of the snake exposition.

DR. E. R. DUNN is on second semester sabbatical leave from Haverford College. The Dunns have spent some time collecting in Panama and are now in Costa Rica where they hope that the beginning of the rains will produce some rare amphibians and breeding habits of forms whose behavior is not yet known. An attempt will be made to determine whether there is any truly temperate herpetological fauna on the higher mountains.

MAJOR CHAPMAN GRANT has sailed recently for Puerto Rico, where he will spend some months collecting reptiles and amphibians on this and adjacent islands, supplementing his fine earlier collections from this area.

M. GRAHAM NETTING, Secretary of our Society, wishes to receive from American museums or institutions the following information: (1) the approximate number of genera, forms, and specimens of amphibians and reptiles in their collection; (2) a statement of the groups or geographical regions which are most completely represented in their collection; (3) the standard or preferred abbreviation by which specimens in their collection should be designated in published lists of specimens. Mr. Netting also requests that herpetologists send to him a list of the North American amphibians and reptiles in which they are specially interested.

Fisheries News

THE INTERNATIONAL FISHERIES COMMISSION has moved into its new quarters, Fisheries Hall No. 2, University of Washington, Seattle, Washington.

DR. WILLIAM J. DAKIN, professor of zoology at the University of Sydney, advisor to the Australian government in fisheries administration, recently spent several weeks on the Pacific and Atlantic coasts visiting fisheries laboratories and studying our fisheries and fishery industries.